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TWO RUMORS.

It is reported in Wall Street that negotiations have been reopened between the General Electric and Westinghouse companies with a view to arriving at an amicable arrangement with respect to patents The recent rise of General Electric in the stock market has been ascribed to this rumor, but there does not seem to exist any ground whatever for its currency. The other rumor is that the Manhattan Elevated Railway has finally decided to supersede steam with electricity for motive power, but for this also no confirmation can be found. Periodically for some years it has been reported that this change was about to be made, but the time has now arrived when we may expect soon to hear that a really definite decision has been reached, though there seems to be no ground for believing that this has yet been done.

DIFFERENT POINTS OF VIEW.

The several different articles in this issue dealing with the reactance of alternating circuits show in what radically different ways the same matter may be treated. Taking, for instance, the subject of the neutralization of an inductance by a capacity in one place the explanation is based upon the practical conception of a choking coil and of a condenser, in which the former is considered to throttle a circuit and the latter to create a draft in it; acting in opposite directions, these two effects cancel each other when they have the same value, and the circuit acts as if it were non-inductive. By the graphical method of Messrs. Houston and Kennelly it is simple to see that in laying down the impedance diagrams for a circuit containing both inductance and capacity, since the values are applied in opposite directions they will cancel when equal; the impedance is thus made equal to the resistance, or the circuit acts as if non-inductive. The method of exposition adopted by Prof. Rosa is the analytical one, and while, perhaps, the most difficult to follow, has the advantage of more minutely considering each phase of the various phenomena and enabling quantitative expressions to be derived. It has, however, the disadvantage inherent to analytical methods, which consists in what we may call the machinery of analysis distracting the attention from the physical view, and the substitution of artificial or abstract conceptions for natural ones. The trained physicist, of course, is not misled by these ulterior considerations, but to others the introduction of conceptions not intimately connected with the subject under treatment is likely to increase rather than diminish the difficulty of understanding it. This of course does not apply so much to students whose education includes the methods of analysis, as to those who wish merely to understand a given subject without regard to other subjects with which it may be connected, and in which they have no interest.

RECENT PATENT DECISIONS.

Judging from letters we have received relating to the recent Berliner decision, considerable misconception seems to prevail as to the application of the decisions in the Bate and Miller vs. Eagle cases. We think it well, therefore, to repeat that the decision in the Bate Refrigerating case is held to have merely decided that revised statute 4887 means what it says—that a domestic patent expires with a foreign patent issued prior to the date of *issue* (not *application*) of a domestic patent granted to the same inventor for the same invention. The decision does not apply to the case of another inventor taking out a foreign patent for the same invention as an American patentee and prior to the date of issue to the latter, for this case is well covered by other principles. If the foreign patent is granted to the second inventor prior to the application for a domestic patent by the first inventor, it constitutes publication, and, therefore, bars the latter from obtaining a patent regardless of priority of invention. If, however, a foreign patent is granted

one person ubsequent to the application of another for a United States patent on the same invention, and the latter patent is then issued, but later than the date of issue of the foreign patent, the question of priority of invention is involved, and may be contested by either patentee in the courts. As to the Miller vs. Eagle decision, it has an importance, not on account of changing any previously existing practice, but because it authoritatively interprets the old established principle that two patents cannot be issued for one and the same invention. This principle has never been contested in its generality, but the decision above referred to is of legal interest from the fact that it gives the opinion of a court of last resort as to its application in an involved case. While a principle may be universally recognized, there are always cases in which its application is doubtful. The opinions of higher courts are, therefore, carefully studied by lawyers in such a case in order that they may strengthen their side by the great weight of precedent, thereby often exaggerating the real importance of a case appealed to, as in the present instance.

PHASE DIFFERENCES IN ALTERNATING CIRCUITS.

In another column we print a very lucid article on phase differences in alternating-current circuits, which appears to be a subject of some difficulty to those first taking up the study of alternating currents. As will be seen by reference to the article, there are two distinct ways of looking at the matter of lag, one with respect to the circuit as a whole, and the other with respect to each of the parts of the circuit. The lag between the E. M. F. generated in the dynamo and the current flowing is a resultant of all the reactions in circuit, including that of the dynamo, but as to whether this total lag is great or small, the devices in the exterior circuit have, so to speak, no knowledge, the lag in each device being dependent on that device alone. However great this total lag may be, in a non-inductive portion of the circuit, such as one containing incandescent lamps, the current will be in phase with the E. M. F. between the terminals; and in a portion containing inductance, the lag between the terminal E. M. F. and the current will depend only on its own reactance. A simple way of illustrating the effect of lag is to draw a sine curve representing the current in a circuit, and then to draw a smaller curve representing what we may call the "choking" effect of an inductive device included, or its reactive or counter E. M. F. due to the passage of the given current; this will also be a sine curve, but crossing the axis 90 degrees *behind* the first curve. The resultant of these two curves will give a third sine curve lagging behind the first one, and if the second curve is drawn to the same scale as the first one with respect to the E. M. Fs., the angle of lag between the current and impressed E. M. F. may be read from the scale of abscissæ. From this it will be seen that the cause of lag is the creation by the current passing through a device having inductance, of a reactive E. M. F. which, when compounded with the forward E. M. F., gives a resultant out of phase with the current. The case is to some extent comparable with that of a direct current motor; in the latter the forward and back E. M. Fs. are represented by straight lines and their resultant is a straight line, but in the case of an alternating current we have two sine curves, one 90 degrees behind the other, whose resultant is a sine curve having an intermediate lag with respect to the E. M. F. which would obtain in a non-inductive circuit, where, of course, it would be in phase with the current. If there are both a capacity and an inductance in a circuit, then we may draw another reactive E. M. F. curve representing what might be called the "sucking" effect of a condenser, which curve, however, will cross the axis 90 degrees *ahead* of the current curve. Finding, then, the resultant of the three curves, we will have a lag or advance of the E. M. F. with respect to the current, according to whether the inductance or capacity curve is the greater; if these two curves are of the same value, corresponding ordinates will have the same value, but one being positive and the other negative, they cancel and the E. M. F. remains in phase with the current. This latter case shows very clearly how a circuit having inductance, may, by the addition of a capacity, be made to act as a simple non-inductive circuit, the E. M. F. and current remaining in phase. As to the effect of lag, since the energy developed at any instant is the product of the current and E. M. F. at that instant, it has a maximum value when these are in phase and decreases until the difference in phase becomes 90 degrees, when there is no useful energy developed, notwithstanding that a large current may be flowing. As a consequence, to develop a given energy where there is lag, a greater E. M. F. and current at the dynamo are necessary, but on account of the lag, no more work is expended beyond that necessary to supply the increased C^2R loss in the line and devices on account of the increased current. Additional objections, however, are a greater E. M. F. in the generator, and, therefore, an increased strain on the insulation, and poorer regulation. It is sometimes said that the existence of lag in motor circuits will require a greater weight of line wire than if there were no phase difference; this, however, is doubtful, since the line would probably be calculated for full motor load, at which the current is nearly in phase with the E. M. F., and at any other load, or when running idle, the current would not exceed this maximum value.

Superheated Steam.

No possible improvement of the steam engine of which we have any knowledge at this moment, says Prof. Unwin, offers anything like so great a chance of important economy as the re-introduction of superheating, and especially of superheating to at least 100 degrees or more above the saturation temperature of the steam. He obtained in Alsace, on a very good 500-hp compound mill engine, with jackets and every appliance for economical working, an economy of 15 per cent. Mr. Muir Rumley has fitted a superheater to a Babcock boiler supplying a triple engine, and has obtained an economy of 10 per cent. In both cases the economy is economy of steam, and, therefore, is not due to any increase of boiler surface or increase of efficiency in generating the steam. Lately Prof. Schröter of Munich, has been experimenting with a small special compound condensing engine of only 60 hp, running at the moderate piston speed of 380 feet per minute, and with the not excessive boiler pressure of 165 lbs. per square inch. The high pressure cylinder is not jacketed. The low pressure is jacketed with receiver steam. In this case, in a tube superheater of a rather special construction, in the uptake of the boiler, the steam is superheated to 670 degrees F., or nearly 300 degrees above the saturation temperature corresponding to the pressure. In two trials of six and eight hours' duration, periods quite long enough for accurate determination of results with so accomplished an observer as Prof. Schröter, the consumption of steam was only 10.2 lbs. per indicated horse power hour, and the consumption of German coal of moderate quality only 1¼ lbs. per indicated horse-power hour.

It is often argued that as very little heat is required to superheat steam it cannot produce much effect. The answer is that a small amount of heat rightly applied in preventing initial condensation produces a disproportionately large effect. That is consistent with the strictest principles of thermodynamics. In the engine experimented with by Prof. Schröter, only 8 per cent. of the heat was used in superheating the steam, and to this 8 per cent. the remarkable economy is due. In a steam jacket acting well, about 12 per cent. of the steam used is condensed, and to this 12 per cent. the advantage of the jacket, which often reduces the amount of steam used in the cylinder by 20 to 30 per cent., is due. But the heat from a jacket is much less efficiently applied than the heat taken direct to the interior of the cylinder by superheated steam and used primarily in maintaining the temperature of the admission surface. Further, the quantity of superheat brought into the cylinder in a given time increases with the speed of the engine, while jacket heat diminishes in effect as the speed is greater. The action of the superheated steam is shown clearly enough on the indicator diagrams. In Prof. Unwin's trials in Alsace the wetness of the steam at cut-off in the high pressure cylinder with jacket, but without superheating, was 35 per cent.; with steam superheated 100 degrees it was only 15 per cent. In the trial with the Schröter engine there was no moisture at cut off in the high pressure cylinder, and the steam remained dry nearly to the end of the stroke.

On the Causes Producing Phase Differences in Alternating Current Circuits.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

Considerable difficulty is sometimes experienced by students in electricity in thoroughly understanding the circumstances leading to the difference of phase between electromotive force and current in alternating-current circuits. The authors have thought that the following brief discussion of the leading conditions controlling these influences might, perhaps, be acceptable to those who are not thoroughly familiar with the technical considerations of this subject.

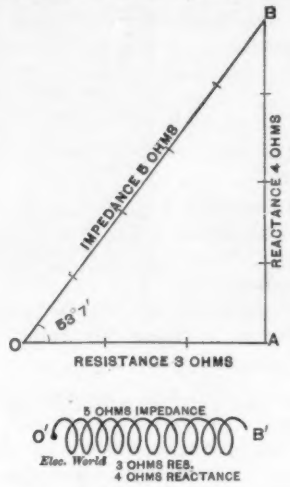


FIG. 1.

The only quality which opposes the passage of a continuous electric current is the resistance of the circuit, the current in such circuit being entirely defined by Ohm's law. In an alternating-current circuit, beside the ohmic resistance, there is also reactance, the combination of the resistance and the reactance of the circuit constituting what is called its impedance. The reactance of the circuit is always added to the resistance, but this addition is not made arithmetically but geometrically; that is to say, if resistance be represented by a straight horizontal line, the length of which stands for its numerical value, then reactance is also represented by a straight line at right angles to this. Thus, if a coil of wire, represented at $O'B'$, in Fig. 1, has a resistance OA, of three ohms, and a reactance AB, of 4 ohms, the impedance of the coil will be OB, or five ohms, as shown. If a continuous E. M. F. of 30 volts be connected to such a coil, it will possess only resistance and no reactance, so that the current strength passing through it will be $\frac{30}{3}$ or 10 amperes; but as soon as an alternating E. M. F. of 30 volts is applied to the coil, then the above reactance of four ohms being assumed, the impedance of five ohms will only permit $\frac{30}{5}$ = six amperes to flow through the coil. Further, the current flowing from the continuous E. M. F. will be driven by the full pressure of 30 volts, and will, therefore, exert an activity of $30 \times 10 = 300$ watts in the coil. The current of six amperes flowing through the coil from the alternating E. M. F. will have the same direction OA, Fig. 1. If the E. M. F. be considered as having the direction OB, that is to say, the current OA, lags behind the E. M. F. at an angle BOA, which has here the value of 53° 07′, or about 1-7th of a complete cycle of 360°. This angle BOA, is called the phase angle, and can in no case exceed or even equal 90°.

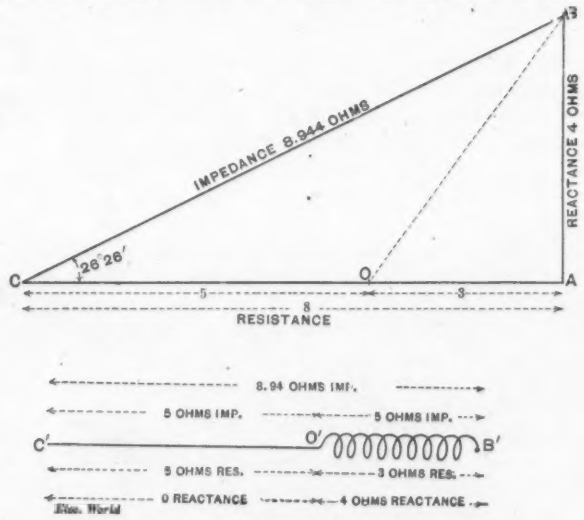


FIG. 2.

The preceding example will make it evident that, although we may say generally that the impedance of a circuit is equal to its resistance, plus its reactance, yet it must be remembered that the addition is made geometrically, and that the phase angle depends upon the relative proportions of the reactance and the resistance. When the reactance is extremely small, the impedance is practically equal to the resistance, and the current strength is practically in phase with the E. M. F. On the contrary, when the reactance is very large, and the resistance small, the impedance is very much greater than the resistance, and the current strength is nearly at right angles to the E. M. F., or almost completely out of step with it. Such a current is usually described as a wattless current, that is to say, a current which requires practically no expenditure of power to maintain it.

In order to show the effect of placing impedances in series, let us suppose the preceding coil of wire to be connected in circuit with a straight length of German silver wire having a resistance of five ohms. The total resistance of the combination will now be $5 + 3 =$ 8 ohms, and the total reactance will be as before, 4 ohms, since the reactance of the straight wire will be negligibly small. The impedance will be 8.94 ohms, as shown in Fig. 2, and the current strength which would flow from an alternating-current pressure of 30 volts connected to such combination would, therefore, be $80 \div 8.94 = 3.354$ amperes.

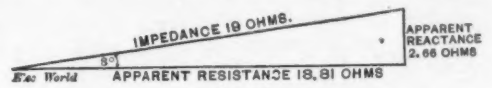


FIG. 3.

It will be observed that the angle of lag in Fig. 2 is only about half that which exists in Fig. 1. This is for the reason that while the resistance of the circuit has been increased its reactance is unaltered. The circuit taken as a whole is less reactant. Each portion, however, of the circuit, taken separately, must, of course, have the current in such phase with the pressure at its terminal, as its impedance diagram would indicate. Thus, in Fig. 2, the coil $O'B'$, will have the current lagging behind the pressure at its terminals by the angle AOB, of 53° 7′. The resistance $C'O'$, will have the current in step with the pressure at its terminals, while the whole circuit $C'B'$, will have the current 26° 26′ behind the pressure at terminals $C'B'$.

If, instead of adding five ohms of reactance less resistance as in Fig. 2, we had added 500 ohms, we should have obtained a circuit in which the lag was very small, and the current, therefore, very nearly in step with the pressure at terminals, but the current in the coil $O'B'$, would still be 53° 7′ behind the pressure at its own terminals.

As a practical example of the foregoing principles we may consider an alternating-current circuit consisting of

(1) A 60-kw alternator operated at 140 periods and 1,294 volts.
(2) A pair of overhead conducting wires, each two miles long.
(3) A 50-kw transformer at the receiving end.

FIGS. 4 AND 5.

If the transformer is operated at full load, it will probably have an impedance of 19 ohms, an apparent resistance of 18.81 ohms, and a reactance of 2.66 ohms, as shown in Fig. 3. It is to be observed that the apparent resistance (18.81) is always greater than the actual or ohmic resistance owing to the effect of its load, and also, in a less marked degree, to the effect of hysteresis in the iron core of the transformer. In other words, the primary coil of the iron-clad transformer behaves as though it had a resistance of 18.81 ohms without an iron core, and a reactance of 2.66 ohms. The angle of lag in the transformer is therefore 8° approximately.

If the two conducting wires are No. 3 A. W. G., and are 20

inches apart, their resistance will each be 2.06 ohms, their reactance 3.09 ohms, and their impedance 3.714 ohms each, as shown in Fig. 4. The current in each wire will therefore, lag 56° 4′ behind the pressure at its terminals.

The alternator may be assumed to have an apparent resistance in its armature of one ohm, and an apparent reactance of one ohm, so that the current lags behind the drop in the armature by 45°, as shown in Fig. 5.

Then if we assume that 1,000 volts is maintained at the transformer primary terminals, the current in the transformer will be $\frac{1000}{19} = 52.63$ amperes.

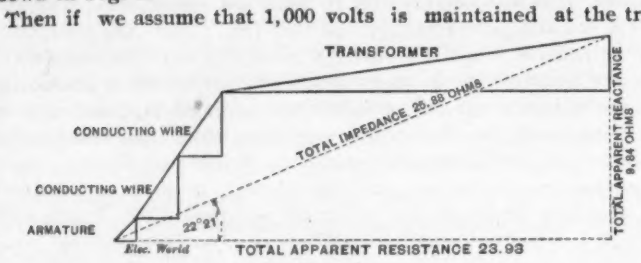


FIG. 6.

The total apparent resistance in the circuit will be

		Reactance	
Armature	= 1.0	Armature	= 1.0
Lines	= 4.12	Lines	= 6.18
Transformer	= 18.81	Transformer	= 2.66
	23.93		9.84

The current in the circuit will, therefore, lag 22° 21′ behind the E. M. F. that is generated in the armature shown in Fig. 6.

If we omit consideration of the armature drop which will be $1.414 \times 52.63 = 74.4$ volts and consider only the lines and transformer, the total apparent resistance will be 22.93 ohms, and the total reactance 8.84 ohms. The current in the circuit will, therefore, lag 21°8 behind the pressure at alternator terminals.

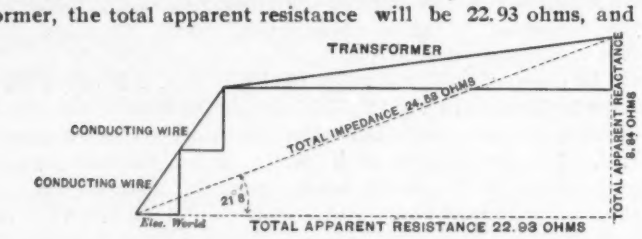


FIG. 7.

The drop in the lines will be $52.63 \times 7.428 = 390.9$ volts (195.45 in each line) and the currents in the lines will lag 56° 15′ behind this pressure. The lag in the transformer 8°, and the lag in the circuit of lines and transformer taken together 21° 8′.

It will be thus seen that when a coil, wire, or conducting device has given resistance and reactance, a definite phase angle is produced between the current and the pressure which acts at its terminals; but the current in the entire circuit will have phase different from the total E. M. F. in the circuit which will depend upon all the individual component parts of the circuit.

The Direct Production of Electricity from Hydrogen.

BY H. H. DOW.

The interest created by the recent articles in THE ELECTRICAL WORLD on the direct production of electricity from fuel or by various forms of gas batteries led the writer to make the following figures on the efficiency with which hydrogen is oxidized in air in the Dow air battery.

This cell contains no depolarizing agent, but depends entirely upon the oxidation of the nascent hydrogen by air to keep it from polarizing. It is composed of zinc and carbon electrodes in a saturated solution of calcium bromide. The carbon used is very porous, and by capillary action holds some of the electrolyte within its pores, although its outer surface is largely exposed to air.

The reaction that takes place on the zinc electrode is expressed by the equation

$$Zn + Ca\,Br_2 + 2H_2O = Zn\,Br_2 + Ca\,O_2\,H_2 + H_2.$$

The zinc bromide and calcium hydrate thus formed react on each other with the formation of zinc hydrate and the same amount of calcium bromide with which we started,

$$Zn\,Br_2 + Ca\,O_2\,H_2 = Zn\,O_2\,H_2 + Ca\,Br_2.$$

The result so far as total energy generated at the zinc electrode is concerned can, therefore, be expressed by the equation

$$Zn + 2H_2O = Zn\,O_2\,H_2 + H_2.$$

The H_2 would, however, when the circuit was closed, appear on the carbon electrode where it would accumulate and polarize the cell unless oxidized.

The reaction that takes place on the carbon electrode is simply the combustion of the hydrogen by the oxygen of the air, producing water.

We may, therefore, represent the original and final products by the following simple equation:

$$Zn + O + H_2O = Zn\,O_2\,H_2.$$

By substituting the heat of combustion for the water and zinc hydrate we find that 82.68 heat units would be developed, which corresponds in this case to almost exactly 1.8 volts if all the energy appeared as electricity.

Similarly, if all the energy was transformed into electricity in the same battery without access of air, according to the equation

$$Zn + 2H_2O = Zn\,O_2\,H_2 + H$$

only .3 volt would be produced. The 1.5 volts difference between the two cases is produced solely by the oxidation of the hydrogen. The actual voltage found in these air cells is 1.32, or 1.02 volts more than if no air had been present.

Therefore, in this case $\frac{102}{180}$, or about 57 per cent., of the total energy contained in the hydrogen was converted into electricity.

This result, showing five times the efficiency of our best steam engines, at first appears very remarkable, but in this case nascent hydrogen was oxidized, while in case of heat engines the free hydrogen is burned.

An experiment with a similar cell having two carbon electrodes and depending entirely on hydrogen gas and air for the production of its current gave less than one tenth of a volt E. M. F.

An American Apparatus for Measuring Hysteresis.

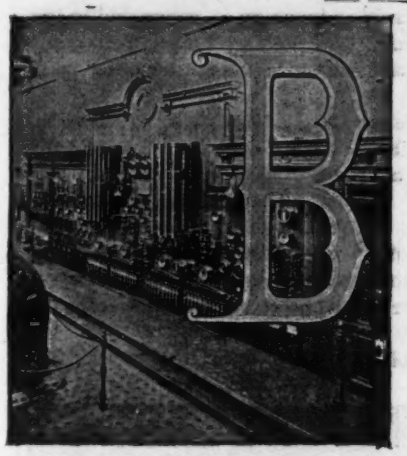
As the ingenious instrument devised by Prof. Ewing* for measuring hysteresis, and described by him in a paper read recently in London, was praised in the highest terms by many of the leading electricians and scientists of England, it will doubtless interest Americans to learn that a very similar instrument was suggested and used by Prof. Elihu Thomson quite a number of years ago, and which in some respects appears to have been even an improvement on the Ewing form.

As early as 1889 Prof. Thomson made some experiments with an instrument for measuring hysteresis which depended on driving sample discs of iron in a magnetic field by a small meter motor and measuring the amount of a current required to be put through the meter, which thus became a measure of the torque exerted in the magnetic field; a speed counter was included in the instrument. The discs were stamped out by a standard punch and a set of them were strung on a vertical shaft; the field in which the armature revolved was furnished by a definite current. He used the instrument for determining the hysteresis in different samples of iron as also in a modified way by taking the bundle of discs and winding on them a simple drum-winding provided with a commutator, by which means he was able to drive the discs, which then became the armature core, between the poles of an electromagnet, the strength of which could be made less or greater; like in the other form the armature current was measured, giving a measure of the hysteresis or the total work done in revolving the bundle in the magnetic field. The friction error was fairly constant and a correction had to be made accordingly. In the other form of apparatus in which the meter armature was driven by a current, the correction could easily be made by revolving the discs and shaft by a current passed through the meter armature while the field which magnetized the discs was removed, making readings at various speeds and noting the current required to drive the apparatus at these speeds; this current deducted from the total with the field on, at any given speed, would show at once the current required to do the work of rotating the discs, that is of supplying the energy lost in hysteresis at various speeds, allowing for eddy current effects.

A modified form of the instrument has been used by the General Electric Company for some time and we believe is still in use by them for testing the samples of iron. We hope soon to be able to furnish a description of this modified and improved form.

*Described and illustrated in THE ELECTRICAL WORLD, May 18, p. 590, and May 25, p. 616.

A Combination Alternating and Direct Current Plant.



BUDAPEST, Hungary, is supplied with electric light service from a plant which leaves no fighting ground for the respective advocates of the alternating and direct-current systems, both being used under peculiarly favorable conditions. In designing the plant the chief requirements which had to be observed were that the generating station must be located outside the city limits, and that low-tension continuous current should be furnished to consumers.

In order to keep down the weight of copper in the conductors connecting the central station with the district where current was to be consumed, and to simplify the generating apparatus, it was decided to generate high-tension alternating currents at a voltage of 1,800, at the primary station, and transform to continuous current of low voltage at a sub-station in the consuming district, by means of rotary transformers, consisting of alternating-current motors coupled to continuous current dynamos. The two-phase system was adopted for the primary end. At the sub-station continuous-current dynamos, direct-driven by two-phase motors, deliver current directly to the distributing network, and also supply current to charge a battery of accumulators in this station. These accumulators carry the load during the lightest period so as to shorten the running time at the primary station, and they also serve to smooth out any fluctuations of voltage in the conductors. The primary station is about 3½ kilometres (2 1-6 miles) distant from the sub-station. The building is mostly taken up by the engine and dynamo room, which is 13 by 24 metres (42 feet 7 inches by 78 feet 8 inches). Adjoining the engine room is the boiler room, as will be seen from reference to Fig. 4; this is 12 metres (39 feet 4 inches) wide by 19 metres (61 feet 9 inches) long. Besides the main room there is a subsidiary engine and dynamo room 10 x 15 metres (32 feet 6 inches x 48 feet 9 inches), containing a sort of temporary plant which was installed prior to the completion of the regular plant in order to satisfy the clamor for service. Outside the building are the stack, water-cooling tower, coal shed and scale house.

The regular boiler plant consists of three so-called Tischbein boilers, each having 150½ square inches of heating surface, and two Steinmüller water-tube boilers, each having 166 square inches of heating surface, all being built for 165 pounds pressure.

The temporary steam plant above referred to comprises two portable boilers and engines, of about 125 hp each, the boilers being of the locomotive type, and each having its engine mounted upon it, as in the case of the familiar portable saw-mill engines and boilers in the United States. The engines are compound, the high-pressure cylinders are 14½ inches in diameter, the low-pressure 24¼ inches, and the common stroke is practically 19 inches (accurately, 48 centimetres). These engines are belted to two two-phase alternators, of 66 kw capacity each. These machines run at 400 revolutions per minute and furnish current at 1,800 volts. Their exciters are coupled to the alternator shafts.

As previously stated, this temporary plant was installed to meet the demand for current pending the completion of the large engines and dynamos, and when the latter were started up the

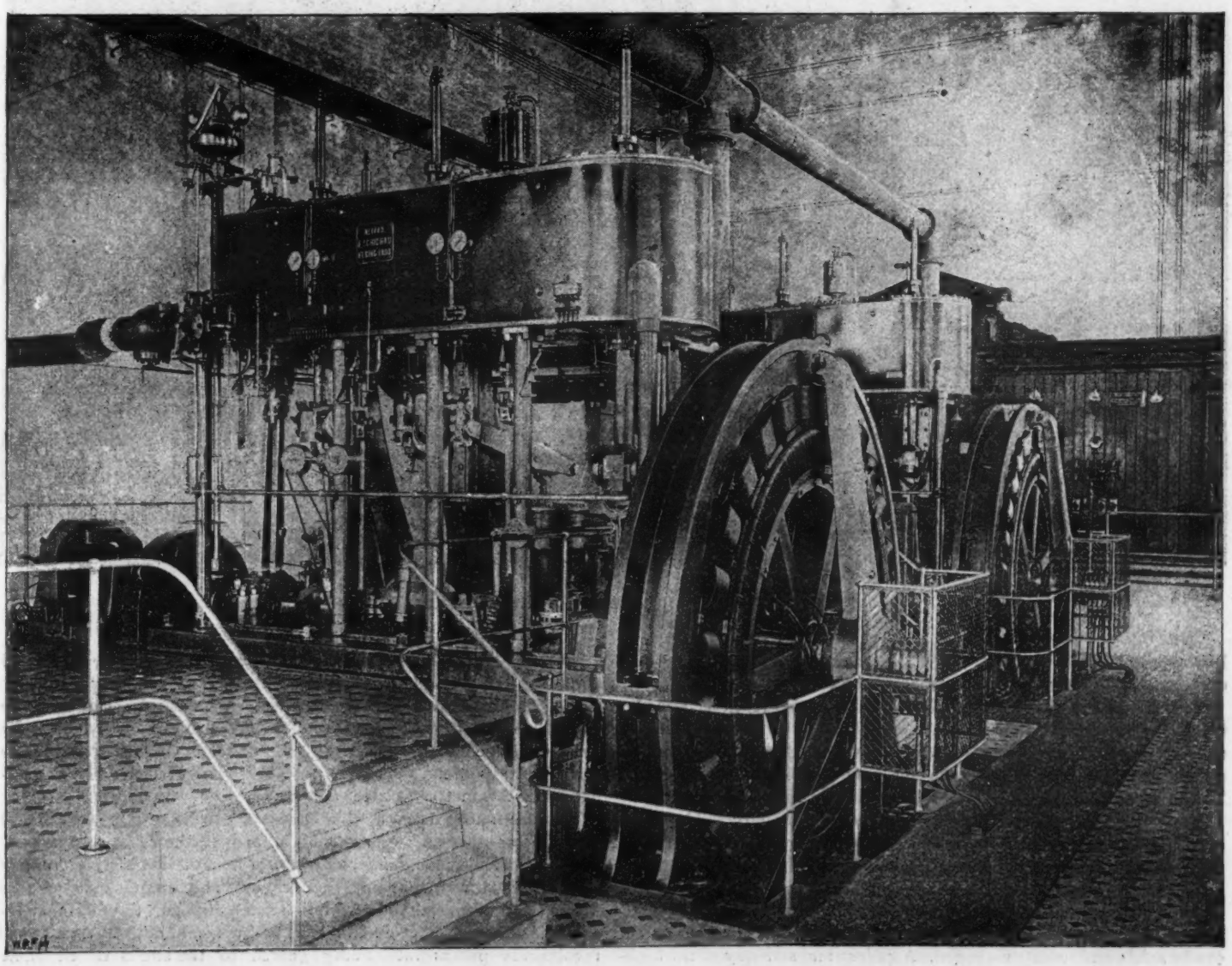


FIG. 1.—DYNAMO ROOM AT PRIMARY STATION.

temporary plant was laid aside, so to speak, as a reserve. The output of the station increased so very rapidly, however, that it soon became necessary to run the so-called temporary plant regularly, along with the large machines.

The equipment in the main dynamo room consists of three vertical triple-expansion Schichau engines, driving three two-phase Schuckert alternators, of 300 kw capacity each, which are direct-connected. The three cylinders of each engine are 46, 75 and 115 cm (substantially 18, 29½ and 45¼ inches) in diameter, respectively, and 5 cm (21⅔ inches) stroke. The engines make 120 revolutions a minute, and, at an initial pressure of 150 pounds in the first cylinder, develop 400 effective horse power normally and 500 horse-power at a maximum, with jet condensation.

The three cylinders, together with the valve chests and receivers, are enclosed by non-conducting material covered with polished tin-plate. Cylinders I and II have steam jackets fed direct from the boiler, and after leaving each cylinder jacket, the steam heats the outside of the receiver of the succeeding cylinder.

Each condenser air-pump is in the rear of its engine, and is driven by the intermediate cylinder crosshead. In case it is desired to work without condensation (which has not yet happened), the exhaust can be turned off from the condenser and opened into the air. The three cranks are set 120° apart, as usual in this type of engine.

The lubricating material for all the moving or inaccessible parts comes from a centrally located reservoir. The waste oil runs to a purifying apparatus in the cellar, from which it is pumped back to a tank in the engine room.

All the indicating and regulating devices are placed on the front side of the engines, in compact arrangement, so that the machinery can be safely and readily managed. A gallery and stairway at the back of the engines allows the higher parts to be reached without danger.

The general arrangement is such that the alternator is coupled directly to the shaft by means of a flange forged to the latter, on the low, pressure side, while the exciting machine is connected to the other end of the shaft by gearing. The flange coupling makes it possible to take out the crankshaft without dismounting other parts of the machinery.

The alternators are built to deliver 300 kilowatts at 1,800 volts, running at 110 revolutions a minute. They have 28 poles, and the number of alternations is, therefore, about 51 a second, this low periodicity being chosen because the only load is the sub-station equipment of motors. The magnet frame is of soft iron, in two parts, and is bolted to a cast-iron bedplate. The poles are cast in one piece with the magnet frame, and the pole-shoes, which are a little broader than the cores, are screwed to the latter.

The armature frame consists of a solid wheel with six spokes on the rim of which there is a bronze ring carrying the laminated armature core. The latter does not rest directly on the bronze ring, but on 16 projections from it, between which the air can circulate abundantly, so that the ventilation of the armature is provided for in the most effective manner. The diameter of the armature is three metres (9 feet 10 inches), and the outer diameter of the magnet frame 3.8 metres (12 feet 5½ inches).

The alternators, large as well as small, can be coupled in parallel with one another and among each other with the same ease as continuous-current machines, and run without the peculiar hum of alternating-current machines generally. The coupling in parallel takes place by means of a simple switch, without the aid of artificial resistances. The exciters are 13-kw machines, and run at 400 revolutions per minute, being geared to the shafts of the same engines which drive the alternators.

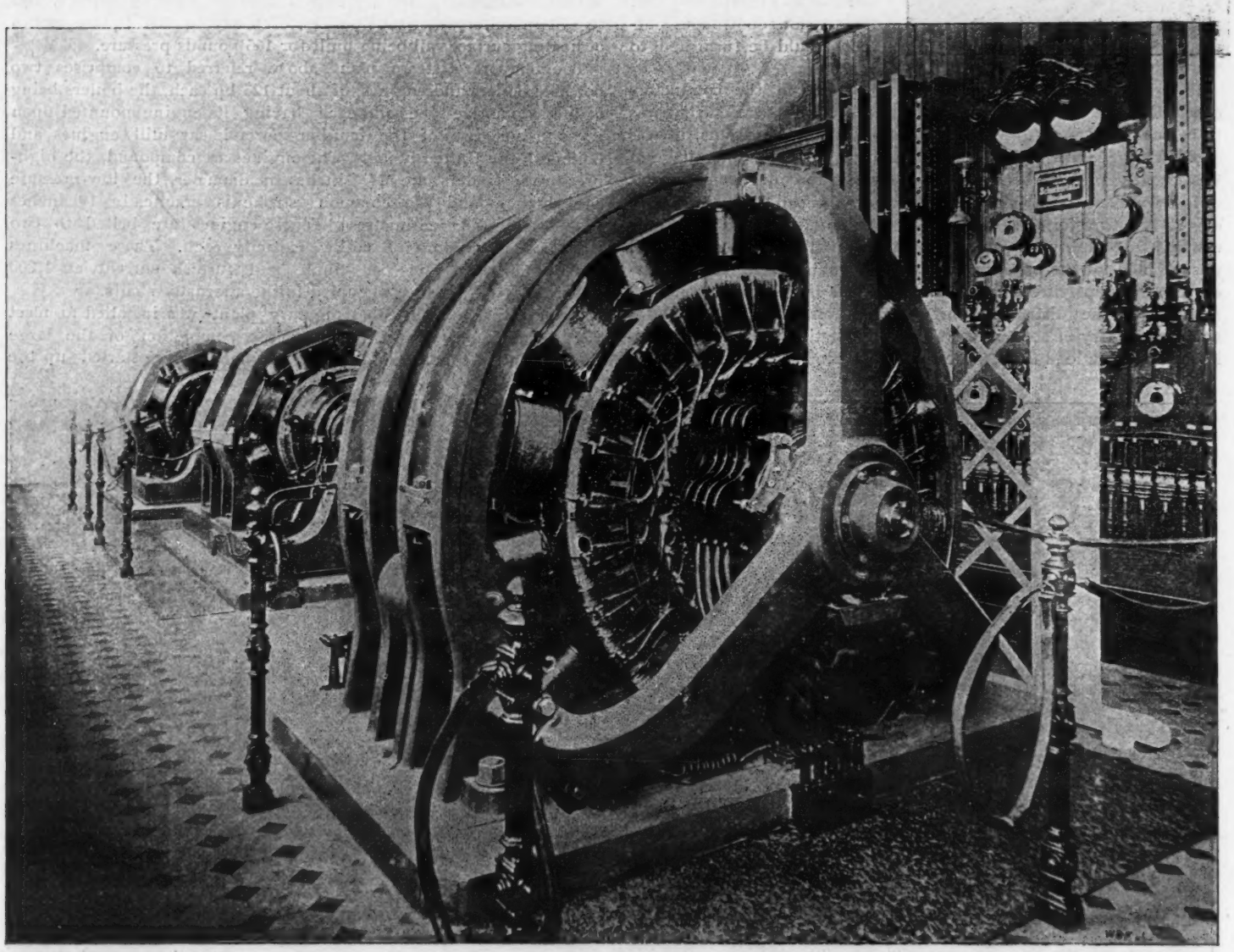


Fig. 2.—Dynamo Room at Sub-Station.

At the acceptance tests, which were most carefully conducted by Dr. Kittler, when the large alternators were run at the primary voltage of 1,780 to 1,790, the current in phase I was 85.7 amperes, in phase II, 90.2 amperes. The energy consumed by the alternator was as follows:

Loss in armature windings,	8,550 watts.
Loss in field winding,	7,450 watts.
Loss due to eddy currents, hysteresis and friction,	17,000 watts.
Total	33,000 watts.

The total energy delivered by the alternator was 284,000 watts; the efficiency of the machine was, therefore, slightly over 90 per cent.

The dynamos are all connected with the switchboard by means of cables, which descend through the ceiling of the cellar, where they are bare and are carried on porcelain insulators. There are two switchboards, one for the portable plant, the other for the main plant, but both arranged on the same system. The middle panel of the main switchboard is occupied by the apparatus for exciting and parallel switching, the left panel by the outgoing cables and their controlling instruments, and the right panel by the switches and instruments of the machines. The current from the alternators first passes through two double pole safety fuses (one for each armature winding), and thence through double pole switches and meters to four bus bars, two for each phase, which are connected through double pole switches to the line conductors.

The electrical plant at the primary station contains also a continuous-current dynamo, of 110 volts and 140 amperes capacity, which generates the current for lighting the station and running the motors of the repair shop, and two non-synchronous two-phase motors, which serve to operate the pumps. The current for these motors is transformed from 1,800 to 110 volts. The pumping plant comprises four Worthington steam pumps, two Sulzer pumps direct-driven by Shuckert two-phase motors, and one Schlick pump belt-driven by a steam engine. The Worthington pumps handle the feed-water for the boilers, and the others are used to lift the condensing water to a cooling tower 11 metres (36 feet 1 inch) high, whence the water falls through sieves to a basin from which it is taken for condensing service.

The sub-station, which is located almost exactly in the centre of the consumption district, is divided into three departments, the general offices, the dynamo room, and the accumulator rooms. The dynamo room contains two 120-kw and two 240-kw rotary transformers, consisting of two-phase motors driving continuous-current dynamos. The dynamos have cast-iron field magnets with wrought-iron shoes bolted on the cores. The two magnet frames are mounted on a common base, and the armatures are built on a single shaft. The armatures of the larger transformers are 1.62 metres (63¾ inches) in diameter, and run at 220 revolutions per minute, at which speed the continuous-current armature gives 240 volts. The acceptance tests of the rotary transformers showed a commercial efficiency of 82.8 per cent.

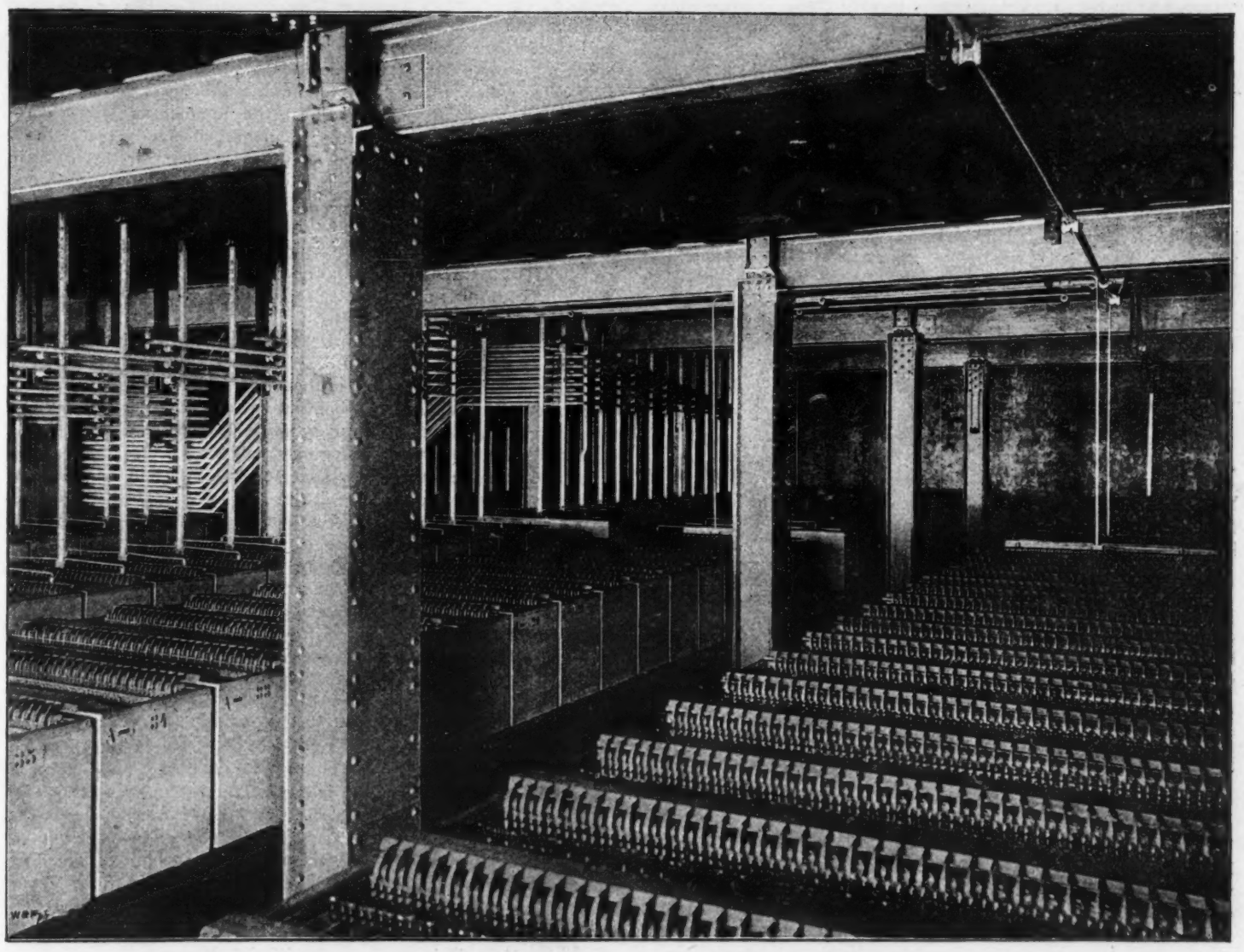


FIG. 3.—AN ACCUMULATOR ROOM AT SUB-STATION.

The switchboard was designed and built by the constructing engineer, Mr. Hubert Sauer. Particular attention has been paid to the convenient and appropriate arrangement of the apparatus, and the safe operation of all parts which have to be handled, so that all the necessary operations may be conveniently performed by one person. These considerations led to the complete separation of the alternating and continuous-current apparatus. The former is placed on the side panels of the switchboard, and in the vicinity of the motors, while the large central panel is occupied by the apparatus for the main continuous current, the exciting current and the

storage battery. All contacts which carry currents of 150 amperes and upward are conical. The accumulator switching device is rather novel. The connections are so arranged that an upward movement of the sliding contact raises the potential and a reverse movement lowers it, which avoids confusion on the part of the attendant. By two complete revolutions of the regulating handle one accumulator cell is cut in or out. When the sliding contact rests on the battery contact bars in such a position that the dynamo current goes directly into the accumulators, or the accumulator current directly into the bus bars, if the handle is then given one complete turn, resistances, which can be varied to suit the current, are thrown into circuit. By this simple contrivance the gradations of potential between adjoining cells are halved, and the cutting in or out of cells is hardly perceptible at the lamps. The battery switches have two contacts, charging and discharging. By a combination reversing switch both contacts can be used for discharging, and it is then possible to divide the feeders into two groups, and to regulate the potential of each group independently. This regulation in two groups takes place particularly at the time of

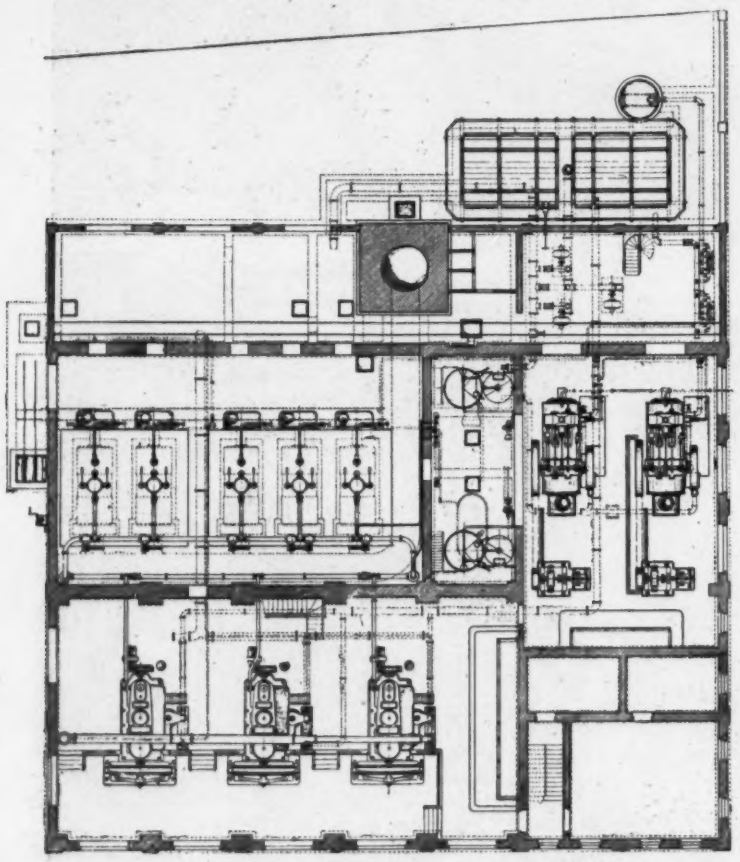


FIG. 4.—GROUND PLAN OF PRIMARY STATION.

highest consumption, when the conducting network is fully loaded. Each sliding contact has a spark arrester to divert the sparking which occurs when cells are cut out, from the track on which the contact slides to a part easily replaced. The usual equipment of instruments is provided for indicating the pressure on the network of distributing mains, total current flow, individual current load of each rotary transformer, etc., etc.

The motors are switched in in the following manner: Current from the accumulators is led to the continuous-current dynamo; the latter runs as a motor and carries with it the alternating machine on the same shaft. When the proper speed of the alternating motor has been reached, and as soon as the latter is in step with the primary alternator, the motor is connected with the primary circuit and the accumulators are disconnected from the direct-current machine, which is then connected in on the distributing mains as a dynamo, in the usual way.

The Tudor system of accumulators is used, and the plant comprises four batteries of 148 cells each, connected in parallel. Each of these batteries has a capacity of 1,565 ampere-hours, with a discharging current of 469 amperes, or 2,245 ampere-hours with a discharging current of 268 amperes. The maximum charging current is 391 amperes. The whole accumulator plant has consequently a capacity of 6,260 ampere-hours with a discharging current of 1,876 amperes, or 8,980 ampere-hours with a discharging current of 1,072 amperes, and can, therefore, take care of 7,500 16-cp incandescent lamps for 3½ hours, or 4,288 lamps for 8⅓ hours. Of the 148 cells forming each battery, 12 (six at either end of the battery) are not yet connected up, as the necessity for raising the present normal working potential has not yet arisen.

The batteries are symmetrically set up in the four stories of the accumulator house. Each story holds a complete battery of 148 cells. The four batteries are connected in parallel by vertical conductors, passing through the four stories.

The conducting network embraces the most frequented streets of Budapest, and consists of three-wire distributing mains, interconnected. To different points of this network are led 20 feeders, whose section depends upon their length and load. Three of them go to collecting boxes, which are intended for the reception of feeder equalizing conductors. The remaining feeders lead to distributing boxes, from which the individual distributing conductors go out. The different sections of the distributing conductors are connected together by means of cross connecting boxes.

When the feeders and distributing network were designed the anticipated losses were carefully calculated, and it was thought that ample allowances had been made for the greatest probable increase in service which might occur for quite a long period. However, the unexpectedly rapid increase in the number of lamps connected to the system, made these calculated allowances inadequate, and, in consequence, differences of pressure arose rapidly between various points of the distributing network, which differences were increased by the unequal loading of the two sides of the system. In order to do away with these differences, two new equalizing conductors were laid in the city, and besides this, the feeders were divided into two groups, one lightly loaded and one heavily, whose potential could be independently regulated by means of the battery switch.

The whole conducting network was furnished by the Budapest firm of Jacottet & Co. (later Felten & Guilleaume), and the cables were made in the Budapest factory of that firm. The cables have double lead covering, double iron ribbon armor, and a layer of jute. In the cables connecting the primary with the sub-station, the two conductors are concentrically arranged; all other cables contain only one conductor each. An insulated test wire is laid in with the copper core of the feeders.

The cables are generally laid 80 to 90 cm (2 feet 7 inches to 3 feet) deep in a trench in a layer of sand, and protected from disturbance by a covering of tiles. In the sub-station the cables are placed in a special conduit. The distributing conductors are laid under both sidewalks of the streets, about 81 cm (32 inches) beneath the surface, and 1 to 1½ metres (39 to 59 inches) away from the house fronts. The number of connections made to the network is 476, and by means of these 810 places are supplied with current. The weight of the copper in all the cables laid is 306,600 kg. (301 tons).

The following requirements concerning the conducting network were laid down for the contractors: The insulation resistance of the cable, at 15° C., must be, at least, 100 megohms per kilometre (about 161 megohms per mile) at the time of acceptance in the factory, and when laid down and during the guaranteed period, five megohms per kilometre (eight megohms per mile), including all connections and soldered places up to the safety fuses at the consuming points. For the determination of the insulation resistance, a source of electricity is to be used whose E. M. F. shall equal the working potential in the conductors.

The Budapest plant was governed by the same conditions which regulate all central stations where accumulators are used. In the primary station comparatively large steam engines were chosen for working units, because they are more economical than a number of smaller ones having the same total power, take up less room, require less attendance and amount of lubricant, and have a higher efficiency. During the past working year, the engines have been almost always run at their normal capacity, and in this way the regulation at the switchboard was also made extraordinarily simple, being confined to cutting the machines in and out. When the engines are started, the charging of the accumulators begins, and this continues until the hour of greatest current consumption, when the accumulators are disconnected, leaving the dynamos only the distributing mains to supply. As soon as the consumption begins to diminish, and there is not enough direct load for the engines, the charging of the accumulators is renewed until the consumption loads so decreases that the batteries are able to take care of the lighting alone for the rest of the working day.

In order to eliminate the annoyance due to the unequal discharging of the batteries used on the two sides of the three-wire system, a so-called "compensating dynamo" was installed recently, which, when necessary, completes the charge of that half of the battery which had discharged at a greater rate than its mate on the preceding day.

The time during which the accumulators handle the whole load varies with the season. The total energy given to the conducting network came from the accumulators and the dynamos directly in the following proportions during the last half of 1894:

	From accumulators. Per cent.	From dynamos direct. Per cent.
July	88.3	11.7
August	63.1	36.9
September	40.2	59.8
October	34.2	65.8
November	36.5	63.5
December	35.7	64.3

For the last half of 1894 the coal consumption was 295.65 tons for heating up, and 2,260.35 tons for running, making a total of 2,556 tons. Of this quantity 111.8 tons were lost in slack, and 44.84 tons in ashes.

The average service furnished by the accumulators for the year was 57½ per cent. total running time, so that even during the busiest season only one shift of men was needed at the primary station. The total charge for 1894 amounted to 391,179.3 kilowatt-hours, and the total discharge was 299,905.7 kilowatt-hours.

Mr. Etienne de Fodor, manager for the Budapest Electric Company, to whom we are indebted for the data herein contained, is an old Edison man, having been connected with the European Edison Company from 1881 to 1889, when he established the central station in Athens, Greece. In May of last year Mr. Fodor left Athens to take charge of the Budapest station, and it is largely to his very efficient management that the signal success of the plant is due.

Efficiency of the Steam Engine and Dynamo.

In popular writings, says Prof. Unwin in a recent lecture, nothing is commoner than to find the efficiency of electric machinery and of steam machinery contrasted to the great discredit of the latter. The dynamo, it is said, has an efficiency of 90 per cent. to 95 per cent., the steam engine an efficiency of only 10 per cent. What a barbarous machine, after all the labor of a century, the steam engine must be! The comparison is generally made by an electrical engineer, and the first reflection which occurs to one is that of all people the electrical engineer should be the last to abuse the steam engine; for, whatever may be the case in some future century, at present the dynamo is absolutely dependent on the steam engine. Without the steam engine the dynamo would be a useless mass of metal and wire. But passing over the moral aspect of the question, the ingratitude of the electrical engineer, the comparison is an unfair one, and shows a want of apprehension of that important law of the motivity of heat which is one of the two fundamental laws of thermodynamics. Heat energy is undirected or mob-energy. It lies in the nature of the terrestrial conditions in which use has to be made of it, that only a fraction is convertible into directed or mechanical energy. The task of the steam engine is to do its best with the fraction which is convertible, and in that point of view it is not an inefficient machine. The dynamo has a much easier task. Energy is supplied to it in its directed or wholly convertible form, and naturally in transforming one kind of directed energy into another kind of directed energy only a small fraction need be wasted.

Electrocution.

We have always held, says the London *Electrical Review*, that the method of executing criminals, adopted in the State of New York, is swift and sure. Others have recklessly asserted that the shock did not really kill, and that the wrongdoers paid the penalty of their crimes under the surgeon's knife on the post-mortem table. Dr. J. Mount Bleyer claims, however, to have now set all doubts aside, and he assigns the true cause of death to be dynamic apoplexy. The most convincing proof of what had been well known to him since 1888 is afforded by the case of David Hampton, who was "electrified" at Sing Sing, N. Y., on Jan. 28 last, and whose lesion of internal organs and hemorrhages show death to have been instantaneous and painless. The notes of the post-mortem made by Dr. Aug. Goelet certainly make it perfectly clear that the surgeon's knife is not the executioner. Dr. Bleyer, it is noted, substitutes "electrification" for electrocution.

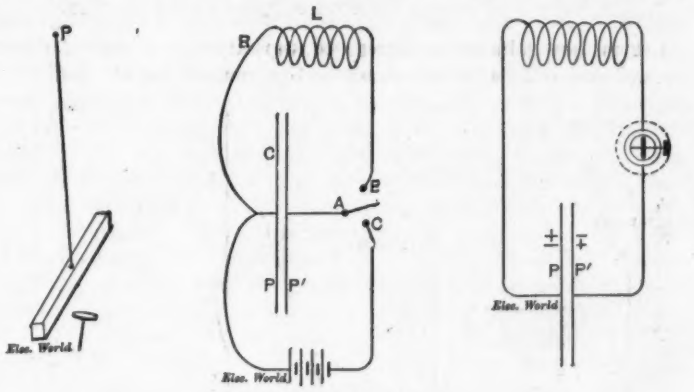
Self Induction and Capacity.

BY E. B. ROSA.

The neutralization of self induction by a capacity has been the subject of ample mathematical treatment, but to a very large body of workers in electrical fields the equations are unintelligible and the subject mysterious. Even to the mathematical student, after he has proved that a certain critical value of the capacity of a condenser will neutralize the self induction of a circuit, and the current will therefore follow the simple law of Ohm, it is often a mystery how the thing is done. In the case of the secondary circuit of an induction coil whose lines of force are opposed to those of the primary, it is easy to see that closing the secondary will reduce the self induction of the primary, for the effective self induction is proportional to the total number of lines of force passing through the coil for unit current, and whatever tends to reduce this number will reduce the self induction. But there is no such connection between a condenser and a coil; the former has no appreciable lines of magnetic force, and so can neither increase nor decrease the number in the coil. Nevertheless, the self induction *seems* to be neutralized, for the current has the same value it would have if the self induction were wholly or in part cancelled and the condenser were removed. But it is only in appearance. As a matter of fact the self induction remains unchanged. What happens is an entirely different thing.

1. SOME MECHANICAL ANALOGIES.

Before discussing the question further let us consider one or two analogies. Take the case of two stretched strings. Suppose one of them is maintained in vibration and the other, not in unison with the first, is examined. If it is found to be in motion at all, its vibrations are forced and have an exceedingly small amplitude;



FIGS. 1, 2 AND 3.

for the tiny forces acting upon the comparatively heavy string are able to generate only correspondingly small velocities. But as the string is lengthened (for example), it vibrates more and more freely, and when the length is exactly right it comes into perfect consonance with the other string, and the amplitude of vibration is perhaps a hundred times greater than at first. Shall we say that increasing the length of the string has neutralized its inertia, and hence that the small forces acting produce a greater amplitude of vibration? Certainly that would be a very crude explanation.

Again, take the case of a torsion pendulum. Suppose a bar of iron is suspended by a long steel wire, and when displaced oscillates back and forth at the rate of six times per minute. If struck regularly once per second with a light mallet the oscillations of the bar would never be considerable, for the forces are not synchronous with the natural period of the bar. But if the suspending wire be shortened so that the bar oscillates 60 times per minute, then the same light blows of the mallet delivered regularly once per second will soon produce a vibration of considerable amplitude. But of course we do not say that changing the length of the wire has neutralized the inertia of the iron bar. On the contrary, it has attuned the vibrating bar to the periodic forces acting, so that the effect of the forces is cumulative, and when finally the maximum amplitude has been attained, the force of each blow of the little mallet is expended in overcoming friction, and not at all in overcoming the inertia of the iron. The latter is overcome by the torsion of the wire, which is large in proportion as the displacement is large.

2. THE ELECTRICAL CASE.

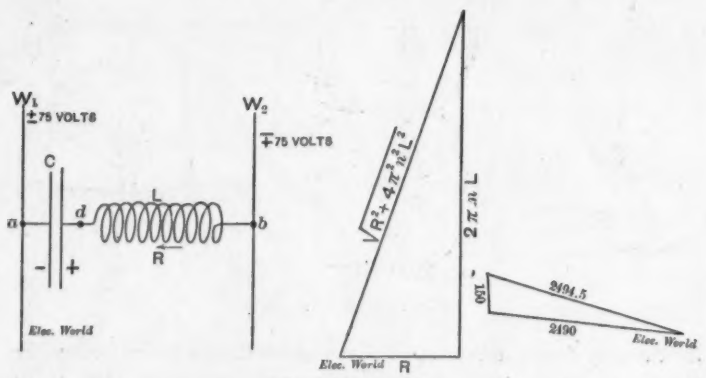
Take now the case of a condenser which is charged and then discharged through a circuit of resistance R and self induction P. If

the resistance is not too large the discharge will be *oscillatory*, and the time of a complete vibration of the electricity from P around through the coil to P^1 and back to P will be very nearly, $T = 2\pi\sqrt{CL}$. That is, the time depends on the capacity and self induction, and not to an appreciable extent upon the resistance. Just as the time of vibration of the iron bar depends upon the moment of inertia of the bar and the torsion of the suspending wire, and not upon frictional resistance.

Now suppose the condenser and coil are joined up in series with a small coil in the centre of which is mounted on an axle a permanent magnet which can be spun in a plane perpendicular to the coil. The lines of force cutting through the coil will induce an alternating electromotive force which will charge the condenser so that each plate is alternately positive and negative. The maximum difference of potential of the plates would be very minute, being equal to the small electromotive force induced in the coil by the rotating magnet. Now let the magnet be spun fast and faster until it is synchronous with the natural period of the coil and condenser. Then; as in the case of the vibrating string and the torsion pendulum, the amplitude is greatly increased by the principle of resonance. The maximum difference of potential of the condenser is many times greater than the induced electromotive force of the coil. The charge of the condenser surges back and forth through the coil in its own natural period of $T = 2\pi\sqrt{CL}$ and the force exerted by the revolving magnet simply overcomes the resistance of the circuit. The current is as great as though the coil had no self induction. The latter is not removed, however; the great difference of potential of the condenser when it is fully charged overcomes it.

3. COIL AND CONDENSER ON ALTERNATING CIRCUIT.

Let us now join our condenser of capacity C and coil of resistance R and self induction L across the main wires W_1 and W_2 of



FIGS. 4 AND 5.

an alternating circuit, having a maximum difference of potential of 150 volts. The potential of each wire varies between the limits + 75 and — 75 volts. As in the last case, if the natural period of the condenser and coil ($T = 2\pi\sqrt{CL}$) is the same as that of the alternating electromotive force, the charge of the condenser will surge back and forth in its own period and the maximum difference of potential of the plates of the condenser will be many times the impressed electromotive force of 150 volts; that is, the charge Q of the condenser will be much greater than if the coil were removed, and the current through the coil greater than if the condenser were removed. This is true to a less degree if the period T of the condenser and coil is not exactly the same as that of the current in the mains. In a particular case, an electrometer connected to b and d gave a deflection of 107 divisions; to a and d of 231 divisions, while to a and b it gave only 86 divisions. Thus the condenser has the effect of *raising the electromotive force* which acts upon the coil, and hence a greater current is forced through it. The self induction is not *neutralized;* it is overcome by an increased difference of potential at the terminals of the coil.

In order that the current in the coil may be a maximum, the period t of the current must be the same as the natural time of oscillation of a quantity of electricity through the condenser and coil; that is, t must equal $2\pi n\sqrt{CL}$. Since $\frac{1}{t} = n$, the number of periods per second, $2\pi n\sqrt{CL}$ or $C = \frac{1}{4\pi^2 n^2 L}$. (1) This is the value of the capacity which will have the effect of neutralizing the self induction, and so give the maximum current through the coil. If $L = 1$ henry and $n = 100$, C is about 2.5 microfarads.

4. KINETIC AND POTENTIAL ENERGY.

While the current flows through the coil from b to d the charge of the condenser is increasing, and hence the maximum charge Q, of the condenser occurs at the moment when the current is zero. On the other hand, as the charge flows out of the condenser through the coil, the current increases up to a maximum, which it reaches when the charge is zero, and ceases when the charge is $-Q$. The energy is all potential and resides in the condenser when the current is zero. The energy is all kinetic and is in the coil when the charge is zero. And these two quantities of energy are equal to each other. This is exactly analogous to the case of our oscillating bar (Fig. 1). Its energy is all potential when the bar comes to rest, and is resident in the twisted wire. The energy is all kinetic when the bar swings through its mean position with a maximum velocity, and there is then no torsion in the wire. And these two quantities of energy are equal to each other; being, indeed, the *same energy* handed to and fro between moving bar and twisted wire. So it is the same energy in the electrical case, handed to and fro between condenser and coil, appearing as potential energy of the stressed dieletric of the condenser in one case, and kinetic energy of the magnetic lines of force in the ether surrounding the coil in the other. The potential energy of the condenser is $\frac{1}{2} Q_o V$ or $\frac{1}{2} C V^2$. The electro-kinetic energy of the current in the coil is $\frac{1}{2} I I_o^2$, where I is the maximum current in the coil. Hence $C V^2 = L I_o^2$. (2) But when $C = \frac{1}{4\pi^2 n^2} L$, the self induction is apparently eliminated, for the current has the same value it would have if the self induction were removed and the condenser disconnected. Hence $I = \frac{E}{R}$. Making these substitutions,

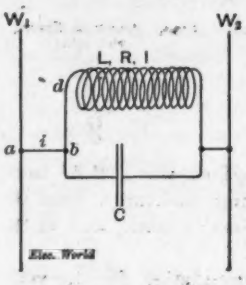


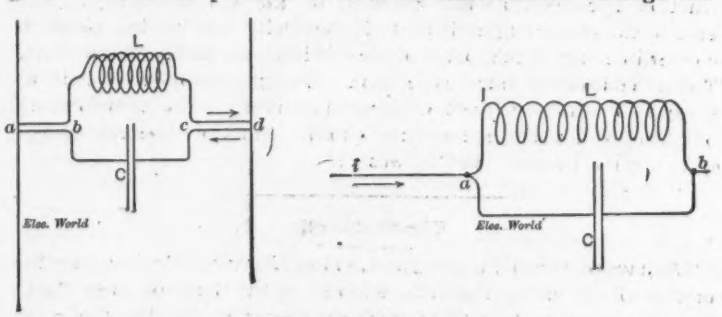
FIG. 6.

$$\frac{V^2}{4\pi^2 n^2 L} = \frac{L E_o^2}{R^2} \text{ or } \frac{V}{E} = \frac{2\pi n L}{R} \quad (3).$$

This result may be stated as follows:

The maximum difference of potential of the condenser is to the maximum impressed electromotive force as the reactance is to the resistance.

This is a most important result, for it shows that when the self induction L, (and therefore the reactance $2\pi n L$) is large, while R is relatively small, that the difference of potential V to which the condenser is charged is much greater than the impressed electromotive force. It is this, as has already been said, which overcomes the impedence of the coil. Instead of actually neutralizing the self induction of the coil the condenser gives us a sufficiently great difference of potential to force the same current through the



FIGS. 7 AND 8.

large impedence that the smaller impressed electromotive force could cause to flow through the ohmic resistance alone.

5. NUMERICAL EXAMPLE.

To illustrate this result let us take the following example:

Suppose the current has 132 complete periods per second. Let the maximum applied electromotive force be 150 volts. The voltmeter would indicate the square root of the mean square and would stand at about 105 volts. Let the coefficient of self induction L be one tenth of a henry, and the resistance R be 5 ohms. Then $2\pi n = 830$. The impedence of the circuit consequently is

$$\sqrt{R^2 + \frac{4\pi^2}{n^2 L^2}} = \sqrt{25 + (830 \times .1)} = 83.15 \text{ ohms.}$$

The current without the condenser is $\frac{10.5}{83.15} = 127$ amperes. The value of V given by the above expression is

$$V = \frac{2\pi n L}{R} E = \frac{830 \times .1}{5} 150 = 2490 \text{ volts.}$$

Thus we see that a maximum electromotive force of 150 volts acting upon the condenser and coil in series produces a difference of potential of 2,490 volts on the condenser, and this great value is attained because of the resonance of the condenser; each small impulse of 150 volts acts just at the right time to increase the displacement. In the pendulum a small periodic force in unison with the pendulum soon produces a large displacement. The force moving a pendulum is principally the torsion of the wire in the torsion pendulum and the force of gravity in the common pendulum, the small applied force simply overcoming friction. So in our electrical case, the force overcoming the great impedence of the coil is principally the great difference of potential of the condenser, the impressed electromotive force only overcoming friction, that is the ohmic resistance of the coil.

The difference of potential of 2,490 volts acts upon the coil together with 150 volts which is a quarter of a period different in phase. The resultant of these two forces is 2494.5, the maximum value of the difference of potential between b and c in Fig. 1. This corresponds to an average value of 1746.15 (I take here as before $\sqrt{.5}$ as .7 for convenience) acting upon an impedence of 83.15 ohms. The average current will be $\frac{1746.15}{83.15} = 21$ amperes. This is the same current that 105 volts would give through 5 ohms, in the case where the capacity and self induction are removed.

This shows also how much greater the stress on the dielectric of the condenser is than the applied electromotive force indicates. If the self induction had been one henry instead of a tenth of a henry, the difference of potential of the plates of the condenser would have been 24,900 volts.

6. RELATION OF CAPACITY TO SELF INDUCTION AND PERIOD.

One is at first thought surprised that the larger the self induction the smaller must be the capacity to neutralize it; the expression $C = \frac{1}{4\pi^2 n^2 L}$ shows this to be the case. Of course the reason is that since the time $t = 2\pi\sqrt{CL}$ in order that the period of the condenser and coil may be synchronous with that of the impressed electromotive force, the product CL must be a constant, and equal to $\frac{t^2}{4\pi^2}$. Therefore C is inversely proportional to L. As an illustration, take again the case of the vibrating string. We bring it into unison with another string. by changing its length, and when that has been done it vibrates sympathetically (we say) through a wide amplitude. Now replace the string by a heavier one, and we find it must be *shorter* in order to vibrate at the same rate. Just so is the case of the condenser and coil, where capacity corresponds to length and self induction to mass; the greater the self induction the smaller must be the capacity in order that the period of oscillation may remain the same. It is evident that if, while the resistance remains the same, the self induction be increased and the capacity therefore decreased in proportion, the maximum difference of potential of the plates of the condenser will be increased. For the same current, and therefore the same quantity of electricity, flows into the smaller condenser as into the larger, and must, therefore, charge it to a correspondingly higher potential.

If, while the self induction remains constant, the period of the current be lengthened, the capacity must be increased. This is evident from the expression (1) for the period of free oscillation of the condenser and coil, and also from the consideration that if the condenser is charged less often, it requires a greater charge each time to give the same average current. But the expression (1) shows that if the period of the current be doubled, the capacity of the condenser must be increased not twice, but to four times its former value. This is explained by the fact that the condenser is charged to only one half its former difference of potential, as (3) shows. And so, with four times greater capacity, if the condenser is charged and discharged only one half as rapidly and to a difference of potential only one half as great, the average current will be just the same. The vibrating string gives us again an analogy. If the time of vibration be doubled while the total mass of the string (corresponding to the self induction) remains the same, the length (corresponding to the capacity) must be not twice but *four times* as great.

7. CONDENSER IN PARALLEL WITH COIL.

Let us now suppose that our condenser is joined *in parallel* with the inductive coil, instead of in series as we have before done. The wires W_1 and W_2 are still supposed to be the constant potential mains of an alternating circuit. By what process can the condenser now have the effect of neutralizing the self induction of the coil?

If a dynamometer be inserted between the points b and d (Fig. 6) it will be found that the *current is not changed* when the condenser is disconnected. This is a very different case from the series arrangement, where the condenser greatly increases the current in the coil. In the present case the condenser cannot increase the electromotive force acting upon the coil, for it is in parallel with it and both are directly joined to the wires W_1 and W_2. Hence, since the self induction of the coil cannot be directly altered, and the electromotive force cannot be increased, we cannot expect the condenser to increase the current in the coil. But it does affect the current flowing from the wires W_1 W_2. If the dynamometer be inserted between a and b when the condenser is joined as shown, the current will be found to be much less than when the condenser is disconnected. In other words, the condenser maintains the same current in the coil while reducing that which flows out of the mains. The amount of this reduction of the line current depends upon the ratio of the impedence to the resistance, when the condenser has the particular value $C = \frac{L}{R^2 + 4\pi^2 n^2 L^2}$. If $R = 5$ ohms and the impedence is 83.15 ohms, as before, then the current will be kept at 1.27 ampere, in the coil, while that in line will be reduced in the ratio of the impedence to the resistance; that is $83.15 \div 5 = 16.63$ times. Hence the line current will be only .076 ampere. If a hundred such coils were joined up to one dynamo circuit, the current would be 127 amperes without condensers and 7.6 amperes with condensers. If the resistance of the armature and line were 1 ohm the C^2R loss would be 16,129 watts without condensers and 58 watts with condensers. (This, of course, neglects the loss in the condensers themselves.) It is evident that to greatly reduce the so-called "wattless" current is a considerable advantage, and hence condensers may be used in this way in connection with transformers, motors, or any apparatus having a large impedence as compared with its resistance. Just how this reduction of the line current is effected may be seen from the following considerations.

8. CONDENSER AND COIL INDEPENDENT.

Suppose the coil and condenser are inserted in parallel as shown in Fig. 7, the connecting wires ab and cd being independent. The current in the coil lags behind the impressed electromotive force owing to the self induction, and if the latter is large the lag will be nearly 90 degrees. On the other hand, the charging and discharging currents of the condenser are 90 degrees ahead of the electromotive force. Thus the difference of phase of the two currents is nearly half a period, so that one is flowing to the right when the other is flowing to the left, and if the two wires ab and also cd are united, the two currents almost cancel each other. The resultant current in ab lies between the other two in phase, agreeing with the impressed electromotive force. As an illustration take the case of the Edison three-wire system. Instead of having large currents flowing in opposite directions in two parallel conductors, the two conductors are united and the current reduced to their difference.

In the case of the condenser and coil it is impossible to have the coil current and the condenser current exactly opposite in phase, unless the ohmic resistance is zero. If the resistance could be zero, then the two currents would be opposite in phase and could be made equal in amount, and so completely neutralize each other. This, of course, neglects dielectric hysteresis.

Another way of looking at this case is to think of the condenser as discharging itself continuously through the coil, the energy supplied from the line simply overcoming the ohmic resistance of the coil.

We see then that in the case of a condenser in parallel with an inductive coil between two constant potential mains, it does not really reduce the self induction of the coil any more than when in series. But it *seems* to neutralize it and at the same time to greatly increase the resistance. For where as a current of say 1.27 amperes flows out of the mains without the condenser, only .076 ampere

flows out with the condenser in parallel, and this small current is in phase with the impressed electromotive force.

9. CONSTANT CURRENT CIRCUIT.

Let us now suppose the coil and condenser to be in parallel, not on a constant potential circuit, but on a constant current circuit, alternating as before. Then, since the average value of the current i is maintained constant, the effect of the condenser will be to greatly increase the current in the coil. For the action of the coil and condenser will be the same as before and the ratio of the currents I in the coil and i in the line will depend only on the impedence and resistance, when the capacity has the particular value $C = \frac{L}{R^2 + 4\pi^2 n^2 L^2}$. But since the coil has undiminished impedance, and the current in the coil is increased in the ratio of the impedance to the resistance, the electromotive force on the terminals a b of the coil will be correspondingly *increased*. In the case already taken, where the ohmic resistance was 5 ohms and the impedance 83.15 ohms, the electromotive force would be increased nearly 17 times. Thus we see that a parallel arrangement of coil and condenser on a constant current circuit has the same effect as a series arrangement on a constant potential circuit; it increases the electromotive force acting upon the terminals of the inductive coil, and so forces as great a current through it as though the self induction were annulled and the condenser not used.

This last arrangement in parellel is very useful on electromagnets of large self induction, as for instance in telegraph instruments on long lines, where it increases the electromotive force acting upon the electromagnet and decreases that spent upon the line, so increasing the efficiency. We see then that a condenser never actually annuls or neutralizes a self induction, although it is convenient so to speak of the effect just as we say "the sun rises." There is perhaps no harm in the expression if we always keep in mind the correct explanation.

Rope Driving—XIX.

BY J. J. FLATHER.

From the foregoing it is obvious that for a given rope and tension the least diameter of pulley which may satisfactorily be used under known conditions should be dependent upon the velocity of the rope, and should vary with the size of the latter in such a manner that, for any given speed, the pulley diameter will be proportional to some power greater than unity and less than the cube of the diameter of the rope. From an investigation of numerous examples in operation under varying conditions, some of which work satisfactorily and others very poorly, it would seem that while the value $15d^2$ may give a suitable diameter of pulley for a soft cotton rope of small diameter, such a value is entirely too small for an equal-sized manilla rope; but on the other hand, $40d$ is somewhat larger than absolutely necessary for these ropes—although it is always desirable to use such a pulley if conditions permit. If for any reason it is necessary to adopt a small pulley, the least pitch diameter for a sheave to be used with manilla rope working under an assumed tension of $200d^2$ pounds may be determined from the following empirical formula, which is believed to represent the requirements of good practice:

$$D = d^{1.7} \times \sqrt[3]{V} + 12''$$

in which D — pitch diameter of pulley in inches;
d — diameter of rope in inches;
V — velocity of rope in feet per minute.

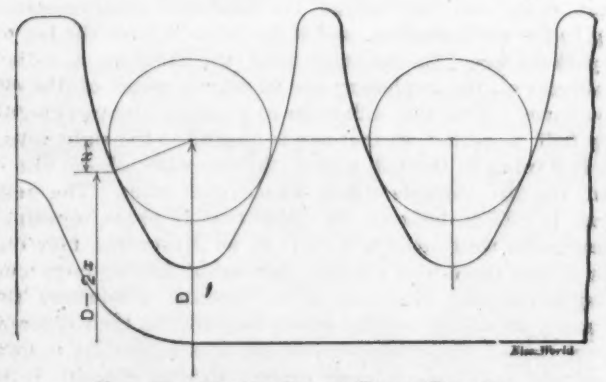


FIG. 49.—DIAMETER OF ROPE PULLEY.

In order to simplify the use of this formula the following values of $(d)^{1.7}$, and $\sqrt[3]{V}$ have been calculated as given in Table XVII. Table XVIII. gives values of D for rope varying from ¾ inch to 2 inches in diameter running at 2,000 to 5,000 feet per minute. When the speed of the rope is not known the diameter given in the last column should be used for the minimum size of pulley; in fact, it would be better to use these diameters, or even larger ones, in all cases, provided the constructive features in the plant will permit their application. With an increased tension in the ropes the diameter of pulley should be increased also. In the same way if the working tension should be less than $200d^2$ pounds, then the diameter of pulley may be less than here given.

If cotton rope be used, the least diameter of pulley may also be taken somewhat less.

TABLE XVII.—VALUES OF $d^{1.7}$; AND $\sqrt[3]{V}$

Diameter of rope, d	¾	1	1¼	1½	1¾	2
Value of $d^{1.7}$	0.61	1	1.46	1.99	2.59	3.25
Velocity of rope, V in ft per min.	1000	1500	2000	3000	4000	5000
Value of $\sqrt[3]{V}$	10	11.4	12.6	14.4	15.87	17.1

TABLE XVIII.—LEAST DIAMETER OF PULLEY FOR GIVEN DIAMETER AND SPEED OF MANILLA ROPE.

$$D = (d^{1.7}) \times \sqrt[3]{V} + 12''$$

Diameter of Rope.	Velocity of Rope in Feet per Minute.			
	2000	3000	4000	5000
¾	20	21	22	22½
1	25½	26½	28	29
1¼	30½	33	35	37
1½	37	40½	43½	46
1¾	44	49	53½	60½
2	53	58½	63½	67

TABLE XIX.—ROPE PULLEYS FOR GENERAL USE.

Diameter of Ropes...	¾	1	1¼	1½	1¾	2
Diameter of Pulleys	24	36	48	60	72	84

It is well to remember that the cause of many failures and much trouble experienced in rope driving is due to the use of too small a pulley for the size of rope and tension carried, but we have yet to hear of a case where the diameter of pulley has been too great. When it is not absolutely necessary to restrict the diameter to the smallest possible which should be used, the least diameter should conform to that given in Table XIX, which has been arranged for general work, and gives least diameters to the nearest half foot, for rope pulleys suitable for all speeds within the limits of good practice.

When a close velocity ratio between driver and follower, greater or less than unity, is required, the pitch diameter of each pulley

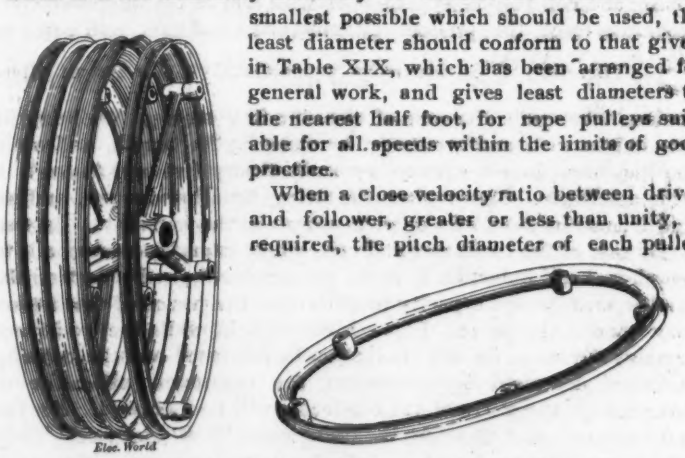


FIG. 50.—BUILT UP ROPE PULLEYS FOR LIGHT WORK.

should be measured from the point of tangency of the rope in the groove, and not from the centre of the rope. For, if D represents the diameter of driver measured to centre of rope, Fig. 49, and F, the corresponding diameter of follower, the velocity ratio will be $\frac{D-2x}{F-2x}$ where x is the common vertical distance between centre of rope and point of contact. Where the pulleys are the same size, it is obvious that the velocity ratio will not be changed, but, as the difference in diameter increases, the influence of x will be more marked; thus, if $D = 3F$, the velocity ratio will be $\frac{3F-2x}{F-2x}$, —a result manifestly greater than $\frac{3F}{F}$. In any case the smaller the

diameter of pulleys for a given velocity ratio, the greater the effect of the quantity x. In ordinary single transmission it will be sufficiently close to assume the diameter of pulley as measured from centre of rope.

It is evident from the previous considerations that the condition and shape of the groove is a matter of much importance; so generally is this recognized that manufacturers now almost universally turn their rims to special gauges and templets which insure uniformity in diameter and shape of groove. Special tools have been

FIG. 51.—ROPE PULLEY WITH TURNED STEEL ARMS.

devised for turning the grooves, and one prominent manufacturer has constructed a special machine in which the rims are milled out.

By this process some of the smaller pulleys are machined in one operation—as many cutters being used as there are grooves to be milled; uniformity of pitch, diameter and contour are thus insured independently of the operator.

Formerly the bottom of the groove was furnished with spikes or the sides were cut into angular teeth in order to prevent the rope from slipping,* but a greater experience with rope driving has shown that the whole surface of the groove must be perfectly smooth, and should be carefully polished as well as machined, since the fibres of the rope, if allowed to rub on a rough turned or cast surface, will gradually break, fibre by fibre, and thus give the rope a short life. It is also necessary to avoid using any pulley with sand or blow holes in the groove, as they are very destructive to a

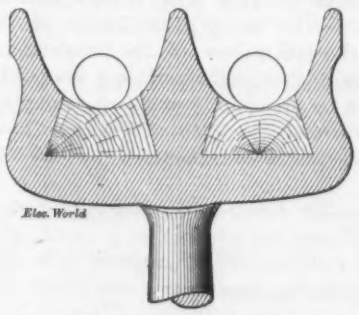


FIG. 52.—WOOD-FILLED ROPE PULLEY.

rope; when blow holes occur, if not honeycombed excessively, they should be filled in with lead, or, preferably, Babbitt's metal, otherwise the pulley should not be used. Some rope pulleys are simply cast and the rims smoothed up by holding a piece of abrasive material such as a broken emery wheel or grindstone against the surface of the groove, while the pulley revolves at a high speed. While this may produce a smooth surface, such an expedient is doubtful economy, for no matter how carefully a multiple-grooved pulley may be cast, it is almost impossible to obtain a rim all the grooves of which are true and of the same diameter; the result is that with such pulleys the ropes tend to vibrate and sway from side to side, rubbing against each other, and frequently against side posts, walls, floors, and other obstructions which rapidly destroys the rope.

Attempts have been made to produce a finished surface in the

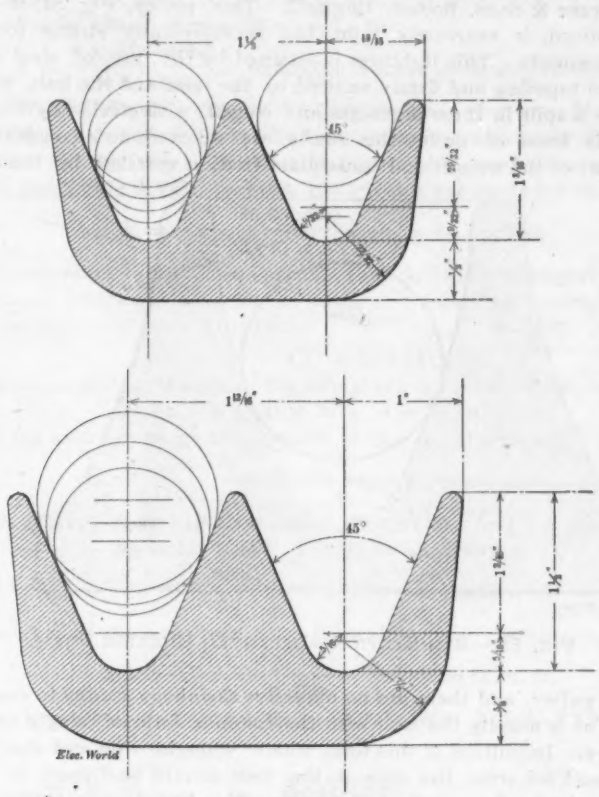


FIG. 53.—RIM SECTIONS.

groove by casting the rim in an accurately turned chill, but such pulleys have not been as successful as anticipated.

A form of pulley introduced by the Link Belt Engineering Company, of Philadelphia, consists of an iron sheave cast in rings, some with and some without arms and hub, from which a complete pulley is built up having the requisite number of arms for strength, and at the same time being light and free from excessive shrinkage strains liable to exist in wheels having light arms and heavy rims and hubs.

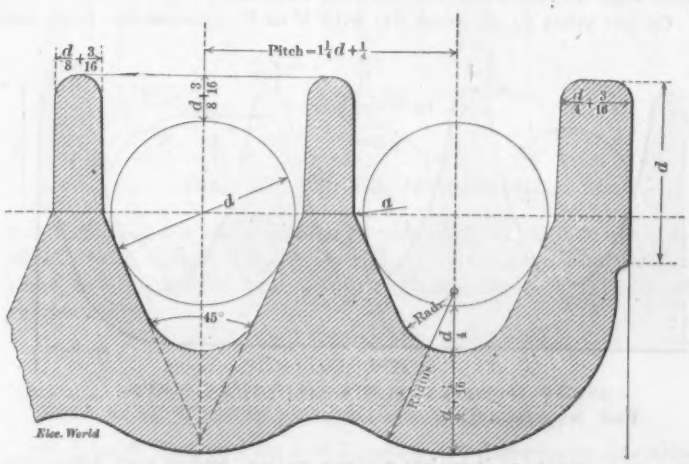


FIG. 54.—RIM SECTION—ENGLISH FORM.

The sheaves have a slight projection on one side and corresponding recess on the other, with bolt holes at the circumference, so that a multiple-grooved pulley with any number of grooves may be readily built up by bolting the sections together, as shown in Fig. 50. These wheels are made from metal patterns and moulded in a three-part iron flask. The core which makes the groove is continuous and of green sand, producing a very smooth casting. The groove is finished with an emery wheel swinging in a frame like a cut-off saw, the final finish being given by the use of emery and oil.

While this process produces a single grooved wheel more cheaply than by turning, it is doubtful whether from a manufacturing standpoint there is any economy in the built-up wheel, when we

* Willis: "Principles of Mechanism."

consider the degree of accuracy now obtained in moulding multiple-grooved wheels and the consequent reduction of labor in turning them.

Another special form of rope-driving pulley is that made by John Musgrave & Sons, Bolton, England. This pulley, Fig. 51, it will be noticed, is extremely light, but is sufficiently strong for the requirements. This lightness is attained by the use of steel arms turned tapering and firmly secured to the rim and the hub, which latter is spilt in three segments and ringed with steel. By the use of this form of pulley the shafts are relieved, to a considerable extent, of the weight and consequent friction entailed by the ordinary pulley, and there are no excessive shrinkage strains to contend with as is usually the case with the common form of single casting pulley. In pulleys of this form where wrought iron and steel rods are used for arms, the ends of the rods should be dipped in acid and tinned before setting in the mould. In addition to this, the rods are sometimes headed up and grooves turned in the ends.

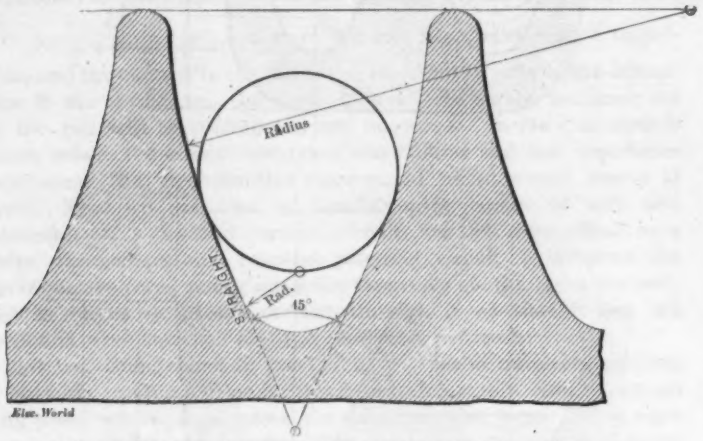
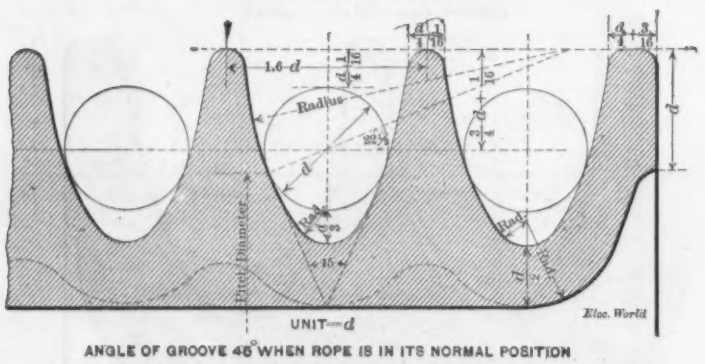


Fig. 55.—Rim Section—Improved English Form.

The bottom of the groove in cast-iron pulleys is sometimes filled with wooden blocks dovetailed into a channel cast to receive them, in which case the rope runs on the bottom and the shape of the groove approximates that shown in Fig. 52. After being fitted and secured, the groove is trued up and turned out to the desired shape. Gutta-percha, rubber, leather, tarred hemp, and other substances have been used for the same purpose; but in the best modern practice a smooth cast-iron surface is preferred to any other, and we find these groove linings confined in most part to pulleys used in wire rope transmissions and hoisting machinery.

Of late years an all-wood rim with V or U grooves has been used to some extent, as it makes a cheap pulley, and is very satisfactory for light work when a semi-circular groove is adopted. Wooden rims, however, should not be used for heavy work, and the slip of the rope should be reduced to a minimum, otherwise the grooves and ropes will be rapidly cut out and the whole system will be very unsatisfactory.



ANGLE OF GROOVE 45° WHEN ROPE IS IN ITS NORMAL POSITION

Fig. 56.—Rim Section—Grooves with Circular Arcs.

The proportions of rope pulley rims depend somewhat upon the shape of groove adopted. Some manufacturers have a standard groove with straight sides which may be used for several different sized rope, as shown in Fig. 53. For light work such a pulley is very satisfactory, and has many advantages in regard to constructive features not possessed by any other form. The groove shown in Fig. 54 * is very commonly used in England, but in this country manufacturers of large rope pulleys usually prefer a form in which the abrupt change in profile (as at *a*) does not occur. Of these, the more common form is a modification of the English section, in which the straight sides forming the angular groove is connected to the rib between the grooves by curves as in Fig. 55.

Another form which has much in its favor, especially for the independent rope system, is the circular arc groove, in which the sides are formed by arcs of circles having a radius approximating 2½ diameters of rope. Working proportions for this groove are given in Fig. 56, in which the unit *d* equals the diameter of rope. It will be noticed that the centre for the curve is located at the intersection of a line drawn through the centre of the rope at an angle of 22½° with the horizontal drawn through the tops of the dividing ribs; the angle of the groove embraced by the rope is thus dependent upon the position of the latter in the groove. In its normal position the angle is one of 45°. The Walker groove as now used in rope pulleys made by Fraser & Chalmers, of Chicago, and the Walker Manufacturing Company, of Cleveland, has its sides formed with circular arcs similar to Fig. 56, but the angle of the groove is more acute; at the point of tangency when the rope simply rests in the groove the angle measures 33°.

Rope pulleys for ordinary transmissions are usually flat on the inside of the rim, or slightly tapered, as shown by the full lines in Fig. 56.

In large wheels, however, the rim is frequently swept up, and where the weight with a flat rim would be greater than required for strength or steady running, the inside is hollowed out, as shown by dotted line. This gives a more nearly uniform section, and makes a stronger and lighter wheel, but the expense of construction is greater.

(To be continued.)

* Low & Bevis' "Machine Design," p. 156.

Practical Notes on Dynamo Calculation.—XXXIII.

BY ALFRED E. WIENER.

Part IV.: Calculation of Magnetizing Forces.
Part V.: Calculation of Magnet Winding.

In the preceding sections of this serial, Part I: Calculation of Armature; Part II: Calculation of Magnetic Flux, and Part III: Dimensioning of Field-magnet Frame, have been treated.

The formulæ and tables thus far given enable the complete design of the armature with its winding and all its details, provide the means of computing the requisite magnetic flux to be set up by the field magnet in order to obtain the required output at the given conditions; and, finally, give the best and most economical dimensions of the field magnet frame of the machine. To complete the design of a dynamo it therefore only remains to calculate the magnetizing force required to produce the necessary magnetic flux, and to find a magnet winding which furnishes the requisite magnetomotive force at the specified increase of field magnet temperature.

As time does not permit the full treatment of the remaining portion in the columns of The Electrical World, the reprint in book form of this serial being in the hands of the W. J. Johnston Company now, the application of the formulæ and tables already given, together with that of the parts not yet published, are, in the following, shown by means of a practical example.

Part VI.: Practical Examples of Dynamo Calculation.

From the numerous cases considered in Part VI. the following be selected:

To design a 300-kw bipolar horseshoe-type dynamo, Edison Type, to give 500 volts and 600 amperes at a speed of 400 revs. p. min. Armature to be a smooth drum; magnets to be of wrought iron and to have a shunt winding producing a rise of 20° C. in field coil temperature.

I. Calculation of Armature.

1. Length of Armature Conductor. In bipolar horseshoe-type dynamos not having a pole bushing or pole bridges (see Chap. 44, Vol. XXV., p. 174), the percentage of effective armature circumference varies from 67 to 80 per cent., corresponding to a polar arc of from 60° to 72°, respectively. In the present example, which is about the limit, in output, to which a bipolar design can yet be carried, the upper limit of $\beta = .80$ can safely be taken for the ratio of polar embrace, for, it follows from Table XV. (Vol. XXIII., p. 743), that the height of the winding space, and, therefore, the length of the air gaps increases in a very much smaller ratio than the diameter of the armature, in consequence of which a greater

percentage of polar arc in a large diameter armature will yet produce a higher ratio of distance between pole corners to length of gap spaces (see Table XLVII., Vol. XXIV., p. 549), than a small percentage will in a small size armature.

For $\beta = .80$, Table II. (Vol. XXIII., p. 712) gives the value of $v = .013$ for the unit armature induction. Consulting Table III. (Vol. XXIII., p. 740), and Table IV. (Vol. XXIII., p. 713), we obtain the conductor velocity and the field density best adapted for the case under consideration:

From Table III.: $S = 50$ feet p. sec.

" " IV.:* $\mathfrak{B} = 30{,}000$ lines of force per sq. inch.

The total E. M. F. that has to be generated in the armature in order to give an output E. M. F. of 500 volts, by Table VI. (Vol. XXIII., p. 713), is:

$$E = e + .03 \times e = 1.03 \times 500 = 515 \text{ volts.}$$

By means of formula (3) we can now at once obtain the length of active conductor for the armature, viz.:

$$L_a = \frac{20{,}000 \times 515}{.013 \times 50 \times 30{,}000} = 530 \text{ feet.}$$

2. Area of Armature Conductor and Selection of Wire. From (4) the cross-section of the armature conductor is found

$$\delta_a^2 = 300 \times 600 = 180{,}000 \text{ circular mils.}$$

Taking three cables made up of 7 No. 13 B. W. G. wires, having .095″ dia. and 9025 C. M. area each, we have a total actual cross-section of $3 \times 7 \times 9025 = 189{,}525$ C. M., the excess amply allowing for the difference between the current output and the total current generated in the armature, see Chap. 6, Vol. XXIII., p. 714.

A cable is preferable in case of a large machine carrying a heavy current, on account of the better ventilation effected by air circulation in the spaces between the single wires as well as between the cables.

In accordance with Chap. 10 (Vol. XXIII., p. 772), a single covering of .007″ is selected for the single wires, and an additional double coating of .016″ is chosen for each cable of seven wires; making the total diameter of the insulated cable, see Fig. 136,

$$\delta'_a = 3 \times (.095'' + .007'') + .016'' = .322''.$$

3. Diameter of Armature Core. The diameter of the armature core is obtained from the mean winding diameter, formula (6), by means of Table VII. (Vol. XXIII., p. 714).

From (6): $d'_a = 230 \times \frac{50}{400} = 28.75$ inches.

From Table VII.: $d_a = .97 \times 28.75 = 28$ inches.

4. Length of Armature Core. The number of cables per layer, from formula (9) and Table XIV. is:

$$o = \frac{28 \times \pi \times (1 - .08)}{.322} = \frac{87.965 \times .92}{.322} = 252;$$

the number of layers, from formula (11) and Table XV.:

$$u = \frac{.8'' - 5/32''}{.322} = 2.$$

Length of core, from formula (12), three cables being in parallel ($p = 3$):

$$l_a = \frac{12 \times 530}{\frac{252 \times 2}{3}} = \frac{12 \times 530}{116} = 38 \text{ inches.}$$

5. Arrangement of Armature Winding. Number of commutator bars, from Table XVI. and formula (15):

$$n > \frac{500 \times 2}{20} < \frac{500 \times 2}{10}; \text{ or } n_{min} = 50, \text{ and } n_{max} = 100.$$

Actual number of armature coils: $n = \frac{252 \times 2}{3} \div 2 = 84.$

Difference of potential between two adjacent bars:

$$\frac{500 \times 2}{84} = 11.9 \text{ volts.}$$

Number of turns per coil, by (17): $m = \frac{252 \times 2}{2 \times 84 \times 3} = 1.$

The armature-winding, therefore, consists of 84 coils, each consisting of 1 turn of 3 cables made up of 7 No. 13 B.W. G. wires.

One armature division, containing the beginning of one coil and the end of the one diametrically opposite, is shown in Fig. 137.

6. Weight of Armature Winding. The total length of armature conductor, from formula (21) is:

$$L_t = 530 \times \left(1 + 1.4 \times \frac{28}{38}\right) = 1{,}075 \text{ feet.}$$

Total weight of wire, bare, from (28) and wire gauge table:

$$lb_a = 1{,}075 \times 21 \times .02732 = 620 \text{ lbs.}$$

Total weight, covered, formula (29) and Table XXI.:

$$lb'_a = 1.031 \times 620 = 640 \text{ lbs.}$$

7. Armature Resistance. From (31):

$$r_a = \frac{1}{4 \times 21} \times 1{,}075 \times .001144 = .0147 \text{ ohm, at } 15.58\ C.$$

8. Useful Flux. From (92):

$$\Phi = \frac{6 \times 515 \times 10^9}{2 \times 84 \times 400} = 46{,}000{,}000 \text{ webers} = 46 \text{ megawebers.}$$

9. Radial Depth, Mean Cross-Section and Average Magnetic Density of Armature Core. Taking a maximum density of 70,000 webers per sq. inch in the smallest cross-section of the armature core, see Table XVII., formula (18) gives a radial depth of

$$b_a = \frac{46{,}000{,}000}{2 \times 70{,}000 \times 38 \times .9} = 9\tfrac{1}{4} \text{ inches.}$$

The maximum depth of the core, b'_a, that is, half the largest chord that can be drawn between the outer and inner core-peripheries can be obtained from Fig. 138:

$$b'_a = \sqrt{14^2 - 4\tfrac{1}{4}^2} = 13.4 \text{ inches.}$$

The mean sectional area of the armature core, therefore, is:

$$A_a = (9.75 + 13.4) \times 38 \times .9 = 792 \text{ sq. ins.,}$$

and the average magnetic density in the armature-core:

$$\mathfrak{B}_a = \frac{46{,}000{,}000}{792} = 58{,}000 \text{ webers per sq. inch.}$$

10. Energy Losses in Armature. From (35), the $C^2 R$ loss is:

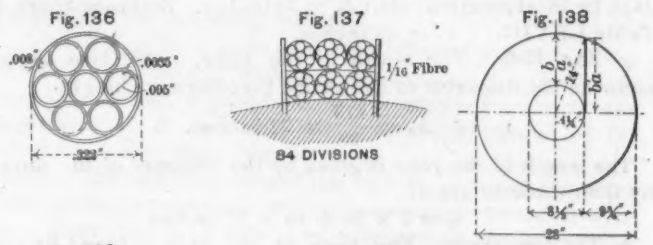
$$w_a = 1.2 \times 600^2 \times .0147 = 6{,}350 \text{ watts.}$$

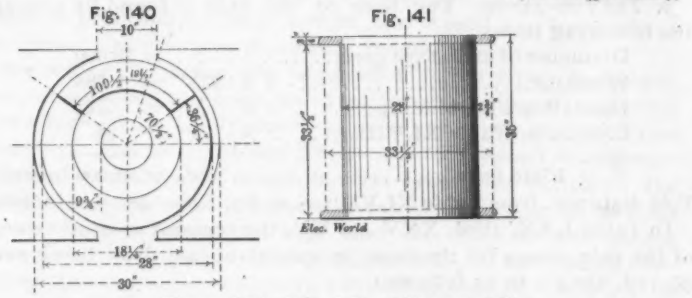
The frequency is $N_1 = \frac{400}{60} = 6.67$ cycles per second.

The mass of the armature core, from (38):

$$M = \frac{18\tfrac{1}{4}'' \times \pi \times 38 \times 9\tfrac{1}{4} \times .9}{1{,}728} = 11 \text{ cu. ft.}$$

The hysteresis factor for $\mathfrak{B}_a = 58{,}000$, from Table XXIV., is





FIGS. 136, 137, 138, 140 AND 141.

$\eta = 20.92$, and the eddy current factor for $\mathfrak{B}_a = 58{,}000$, and $\delta = .020''$, from Table XXVII., is $\varepsilon = .097$; hence the energy losses due to hysteresis and eddy currents, from (39) and (41), respectively:

$$w_h = 20.92 \times 6.67 \times 11 = 1{,}535 \text{ watts.}$$
$$w_e = .097 \times (6.67)^2 \times 11 = 47 \text{ "}$$

The total energy dissipation in the armature, by (42), is:

$$W_a = 6{,}350 + 1{,}535 + 47 = 7{,}932 \text{ watts.}$$

11. Specific Energy Loss and Temperature Increase in Armature. From Table XXIX., the length of the heads of our armature will be:

$$l_h = .35 \times 28 + 2 \times .8 = 11\tfrac{1}{2} \text{ inches.}$$

The radiating surface, consequently, from (44):

$$O_a = (28 + 2 \times .8) \times \pi \times (38 + 1.8 \times 11\tfrac{1}{2}) = 5{,}550 \text{ sq. ins.}$$

The pole area being about $30 \times \pi \times 38 \times .8 = 3{,}040$ sq. ins., the ratio of pole area to total radiating surface is $\frac{3{,}040}{5{,}550} = .55$; and since the peripheral velocity is 50 feet per second, we obtain, from Table XXX., a specific temperature increase of $\tau_a = 45.5°$ C. The rise of armature temperature, therefore, will be, by formula (47):

$$t_a = 45.5 \times \frac{7{,}932}{5{,}550} = 45.5 \times 1.43 = 65°\ C.$$

* See note at the head of Section III. (Vol. XXIII., p. 740).

12. Circumferential Current Density and Running Value of Armature. From (49) we obtain:

$$\gamma = \frac{168 \times \frac{600}{2}}{28 \times \pi} = 572 \text{ amperes per inch of core circumference.}$$

This value is within the load limit given in Chap. 20; the output of the dynamos under consideration, 300 kilowatts, must, therefore, be within the limit of maximum safe output, which is really the case, for, from (53) we obtain:

$$W_{max} = 28^2 \times 38 \times .91 \times 30{,}000 \times 400. \times 10^{-6} = 325{,}000 \text{ watts.}$$

The running value of the armature is found from (54):

$$\rho = 20{,}000 \times \frac{515 \times 600}{620 \times 30{,}000} = 332 \text{ watts per lb. of armature conductor at } \mathfrak{C} = 20{,}000,$$

which is within the practical limits given in Table XXXIII.

II. Dimensioning of Magnet Frame.

1. Total Flux Through Magnetic Circuit. From Table LII. (Vol. XXIV., p. 647), the probable leakage factor of a 300-kw upright horseshoe-type machine is $\lambda = 1.20$, and therefore the approximate total flux:

$\Phi' = 1.20 \times 46{,}000{,}000 = 55{,}200{,}000$ webers $= 55.2$ megawebers.

2. Area of Magnet Frame. The cores and yoke being of wrought iron, the sectional area required, according to Table LIX., is:

$$A_m = \frac{55{,}200{,}000}{90{,}000} = 614 \text{ sq. ins.}$$

3. The Magnet Cores. The cylindrical form of cross-section being chosen, the diameter of the magnets is:

$$d_m = \sqrt{614 \times \frac{4}{\pi}} = 28 \text{ ins.}$$

The length is obtained from Table LXIV. (Vol. XXV., p. 343), by interpolation, viz.: $l_m = 35$ inches. Distance apart, from Table LXVIII.: $c = 16$ inches.

4. The Yoke. The width of the yoke, in the type chosen, is equal to the diameter of the cores, therefore, its height:

$$h_y = \frac{614}{28} = 22 \text{ inches.}$$

The length of the yoke is given by the diameter of the cores and by their distance apart:

$$l_y = 2 \times 28 + 16 = 72 \text{ inches.}$$

5. The Pole-Pieces. The bore of the field is found by adding the following items:

Diameter of armature core		= 28.000
Winding	$4 \times .322''$	= 1.288
Insulation and binding	$2 \times \frac{5}{32}''$	= .312
Clearance (Table XLVIII.)	$2 \times .2''$	= .4
Field bore		d_p = 30.000 inches.

Pole distance, from Table XLVII.: $e_p = 5 \times (30 - 28) = 10$ inches.

In Table LXX. (Vol. XXV., p. 370), the remaining dimensions of the pole-pieces for the case in question, cast iron being employed, are given as follows:

Height of pole-pieces	h_p	= 30½ inches.
Length " "	l_p	= 38 "
Thickness in centre		= 15 "

6. The Zinc Blocks. Table LIV. gives the height of zinc blocks for dynamos of 300 kw capacity and with a 28-inch drum armature as $h_z = 11$ inches.

Fig. 139 shows the field magnet frame thus dimensioned.

III. Calculation of Magnetic Leakage.

The permeance of the gap spaces, from (126), is:

$$P_1 = \frac{\frac{1}{4}\left(28 \times \pi + 30 \times \pi \times \frac{141°}{180°}\right) \times 38}{1.30 \times (30 - 28)} = \frac{1{,}540}{2.6} = 593.$$

The permeance across the magnet cores, from (129):

$$P_2 = \frac{28 \times \pi \times 35}{2 \times .16 + 1.5 \times 28} = \frac{3{,}080}{74} = 41.6.$$

Permeance across pole-pieces, by (114):

$$P_3 = \frac{\frac{1}{2} \times \left[38 \times \left(30 + \frac{30\frac{1}{2}}{2}\right) + 900^*\right]}{2 \times 11} + \frac{2 \times 38 \times 1}{10} = 59.6 + 7.6 = 67.2.$$

Permeance between pole pieces and yoke, by (114) and (115):

$$P_4 = \frac{500\dagger}{35} + \frac{38 \times 30\frac{1}{2}}{2 \times 35 + (30\frac{1}{2} + 22)\frac{\pi}{2}} = 14.3 + 7.6 = 21.9.$$

* Portion of bedplate opposite one pole-piece.

† Projecting area of pole-piece (= area, top of pole-piece—area of magnet core).

Actual leakage factor, from (110):

$$\lambda = \frac{593 + 41.6 + 67.2 + 21.9}{593} = \frac{723.7}{593} = 1.22.$$

The actual total flux, consequently,

$\Phi' = 1.22 \times 46{,}000{,}000 = 56{,}000{,}000$ webers $= 56$ megawebers.

IV. Calculation of Magnetizing Force.

1. The Magnetic Circuit. The magnetic circuit of our machine consists of four different portions:

Air Gaps: Area: $A_g = \frac{1}{4}\left(28\pi + 30\pi \times \frac{141}{180}\right) \times 38 = 1{,}540$ sq. ins.

Length: $l_g = 1.30 \times (30 - 28) = 2.6$ inches.

Density: $\mathfrak{B} = \frac{46{,}000{,}000}{1{,}540} = 29{,}900$ lines per sq. inch.

Armature Core:

Mean density (see above, I., 9): $\mathfrak{B}_a = 58{,}000$ lines per sq. inch.

Specific magnetizing force, from Table LXXI.:

$f(\mathfrak{B}_a) = 12.2$ ampere-turns per inch.

Mean length of circuit in armature core, see Fig. 140:

$$l_{(a)} = 18\frac{1}{4} \times \pi \times \frac{109\frac{1}{2}°}{360°} + 9\frac{3}{4}' = 27 \text{ inches.}$$

Wrought Iron Part of Field Frame (Magnet Cores and Yoke):

Area: $A_w = 28^2 \times \frac{\pi}{4} = 616$ sq. ins.

Length: $l_w = 2 \times 35 + 22 + 44 = 136$ inches.

Density: $\mathfrak{B}_w = \frac{56{,}000{,}000}{616} = 91{,}000$ lines per sq. in.

Specific magnetizing force: $f(\mathfrak{B}_w) = 53.8$ ampere-turns per inch.

Cast-Iron Part of Field Frame (Pole-Pieces):

Least area (in centre): $15 \times 38 = 570$ sq. ins.

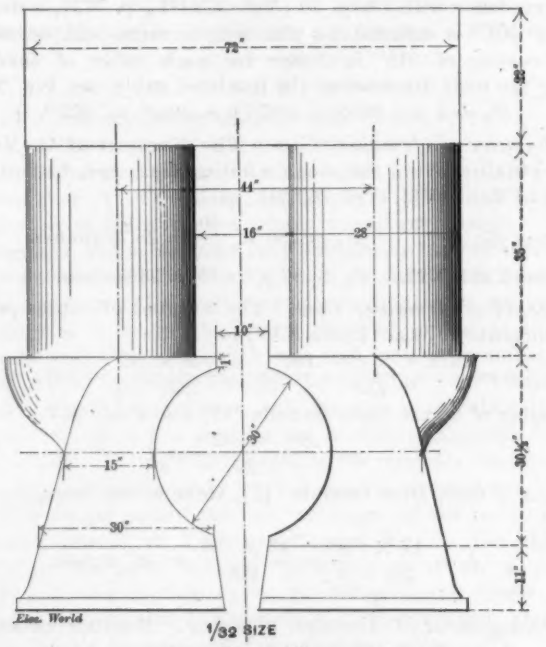


FIG. 139.

Corresponding maximum density:

$$\frac{56{,}000{,}000}{2 \times 570} = 49{,}200 \text{ webers per sq. in.}$$

Greatest area (at pole face): $\frac{30 \times \pi}{2} \times 38 \times \frac{141°}{180} = 1{,}400$ sq. ins.

Corresponding minimum density:

$$\frac{46{,}000{,}000}{1{,}400} = 32{,}800 \text{ webers per sq. in.}$$

Average density in cast iron:

$$\mathfrak{B}_c = \frac{49{,}200 + 32{,}800}{2} = 41{,}000 \text{ lines per sq. in.}$$

Specific magnetizing force: $f(\mathfrak{B}_c) = 93.2$ ampere-turns per inch.

Mean length of circuit in pole-pieces: $l_c = 40$ inches.

2. Magnetizing Forces Required for the Various Portions of the Magnetic Circuit.

M. M. F. required for gap spaces:

$al_g = 0.3133 \times \mathfrak{C} \times l_g = .3133 \times 29{,}900 \times 2.6 = 24{,}400$ ampere-turns.

M. M. F. required for armature core:

$al_a = f(\mathfrak{B}_a) \times l_{(a)} = 12.2 \times 27 = 330$ ampere-turns.

M. M. F. required for wrought-iron portion of frame:
$at_w = f(\mathfrak{B}_w) \times l_w = 53.8 \times 136 = 7{,}320$ ampere-turns.
M. M. F. required for cast-iron portion of frame:
$at_c = f(\mathfrak{B}_c) \times l_c = 93.2 \times 40 = 3{,}730$ ampere-turns.
M. M. F. required to compensate armature reactions:

$$at_r = (k) \times \frac{m \times C}{2} \times \frac{a}{180^\circ} = 1.5 \times \frac{84 \times 600}{2} \times \frac{19\frac{1}{2}}{180} = 4{,}100 \text{ ampere-turns.}$$

Total magnetizing force required:
$AT = 24{,}400 + 330 + 7{,}320 + 3{,}730 + 4{,}100 = 39{,}880$ ampere-turns.

V. Calculation of Magnet Winding.

Magnet winding to be figured to give a temperature increase of $t_m = 20^\circ$ C. over the standard temperature of 15.5° C. Extra regulating resistance at normal load to be 10 per cent. of the magnet resistance.

Radiating surface of magnets, see Fig. 141.

$$O_m = 2 \times (28 + 2 \times 2\tfrac{3}{4}^*) \times \pi\,(35 - 1\tfrac{1}{2}^\dagger) = 7{,}050 \text{ sq. ins.}$$

The conditions of heat radiation from an electromagnet are similar to those of an armature at rest, with pole-pieces removed; for these conditions, from Table XXX. (Vol. XXIV., p. 33), the specific temperature increase of 75° C. for 1 watt of energy loss per sq. inch of radiating surface is derived.

The permissible energy loss in the magnet winding, therefore, is found from:

$$W_m = \frac{t_m}{75^\circ} \times O_m = \frac{20^\circ}{75^\circ} \times 7{,}050 = 1{,}880 \text{ watts.}$$

The total energy absorbed in the entire shunt circuit (magnet resistance + extra resistance) is:

$$W'_m = 1.1 \times 1880 = 2{,}070 \text{ watts.}$$

Current flowing through shunt:

$$C_m = \frac{W'_m}{e} = \frac{2{,}070}{600} = 3.46 \text{ amperes.}$$

Number of turns on magnets:

$$T = \frac{AT}{C_m} = \frac{39{,}880}{3.46} = 11{,}530 \text{ turns.}$$

The mean length of one turn being given by Fig. 141, the total length of the magnet wire is obtained from:

$$L_m = \frac{11{,}530 \times (28 + 2\tfrac{3}{4}) \times \pi}{12} = 93{,}000 \text{ feet.}$$

The total resistance of the shunt circuit, including the extra resistance, is:

$$r''_m = \frac{e}{C_m} = \frac{600}{3.46} = 173.5 \text{ ohms.}$$

The magnet resistance alone, therefore:

$$r'_m = \frac{173.5}{1.1} = 157.5 \text{ ohms at } (15.5^\circ + 20^\circ) = 35.5^\circ \text{ C.}$$

or:

$$r_m = r'_m \times \left(1 - \frac{t^\circ_m}{300}\right) = 157.5 \times .933 = 147 \text{ ohms at } 15.5^\circ \text{ C.}$$

The specific resistance of the magnet wire fulfilling the above conditions is:

$$\frac{r_m}{L_m} = \frac{147}{93{,}000} = .00158 \text{ ohm per foot at } 15.5^\circ \text{ C.}$$

The nearest gauge wire is No. 12 B. & S., having a specific resistance of .001581 ohm per foot; 93,000 feet of this wire will, therefore, give an actual magnet resistance of:

$$r_m = 93{,}000 \times .001581 = 147.1 \text{ ohms, at } 15.5^\circ \text{ C.}$$

The total weight of the magnet winding is:

$$lb_m = 147.1 \times 12{,}503 = 1{,}840 \text{ lbs. bare;}$$

or: $lb'_m = 1.028 \times 1.840 = 1{,}890$ lbs. covered.

The given machine is consequently to be wound with 945 lbs. of No. 12 B. & S. wire (.081″ + .008″) per magnet.

The current density in the magnet wire is

$$\frac{6{,}530}{3.46} = 1{,}890 \text{ C. M. per ampere.}$$

Electrical efficiency of machine:

$$\frac{W}{W + W_a + W_m} = \frac{300{,}000}{300{,}000 + 7{,}932 + 1{,}880} = .968, \text{ or } 96.8 \text{ per cent.}$$

If a temperature increase higher than $t_m = 20^\circ$ C. had been permitted in the field coils, more energy could be spent in exciting the magnets; the shunt current would, therefore, be correspondingly greater and the number of turns correspondingly smaller, resulting in a smaller weight of copper.

* Height of magnet-winding space, from Table LXIII. (Vol. XXV., p. 342.)
† Allowance for core-flanges.

The Berliner Case.

To the Editor of The Electrical World:

SIR:—It is to be hoped that the form of judgment or decree entered in the Berliner case by the Appellate Court will not be such as to adjudicate its validity, else it will be unfortunate, indeed, that the government ever begun proceedings. If the decree of reversal simply overrules Judge Carpenter, and does not pass on the merits of the validity of the patent, others may freely offer defenses against it on these points. If, on the other hand, the decree is not discreetly dissected by the government attorneys, the Bell attorneys may get what they evidently desire, viz.: an order which may be construed by other courts as having been passed upon after a proper consideration of the case on its merits. The charge has been made that this whole government suit was part and parcel of a Bell scheme to get an Appellate Court adjudication on this Berliner patent without submitting to a full test upon its merits from all points. It will depend upon the character of decree entered whether these suspicions will be continued. It is to be desired that the litigation necessarily to follow shall not be hampered by such limitation as could be exercised through the use of the Appellate decree in another circuit.

The seriousness of this whole matter lies in the improbability of any competing company going to the expense of defeating this Berliner patent, in view of the fact that such defeat would amount to no particular value as a victory, for all the clap-trap concerns in the business would tumble over each other in an effort to "steal the fruits" of it.

J. E. KEELYN,

CHICAGO, ILL.

Definition of Polyphased Systems.

To the Editor of The Electrical World:

SIR:—In the May 25th issue of your valuable paper, I saw a letter of Mr. A. Blondel. While the contents of this letter are such that ordinarily I should not think it proper for me to take any cognizance of it, the otherwise well-known name of the writer induces me to say a few words.

Regarding the technical side of the matter, as usual the letter under discussion is based on a mutual misunderstanding, which I hope in a short time to be able to explain completely by a paper which I promised to read before the American Institute of Electrical Engineers at its annual general meeting.

Regarding, however, the suggestion of the letter, that commercial reasons have been the cause for attempting to introduce a new definition of polyphase systems, I consider the *perversion of scientific facts or definitions for commercial purposes as dishonorable*, and I am afraid I would have to denote the action of the writer to impute such purpose without sufficient proof, *with the same name*, if I would not hope that Mr. Blondel has passed these remarks by mere inadvertency, without sufficiently considing their bearing: although I should expect from a writer of his reputation greater care in weighing the meaning of his words.

CHAS. PROTEUS STEINMETZ,

SCHENECTADY, N. Y.

The Arnold Motor.

To the Editor of The Electrical World:

SIR:—Undoubtedly you thought of bringing before your readers a new alternating-current motor, and one which may have been tried and used in practice in Europe, when you described the patent recently issued to Prof. E. Arnold.

With this very impression I started to read the interesting description, but at the close I felt disappointed. To my surprise I found in the description a motor for which a United States patent was granted to me in 1891.

In principle the motors are identical in construction. However, there are some differences, the merits of which I do not wish to discuss at this moment. Suffice it to say that the older patent broadly covers the ground.

LUDWIG GUTMANN.

CHICAGO, Ill.

[The article on Prof. Arnold's motor above referred to was confined merely to a general description of the motor, and did not cover numerous points of detail which are contained in the patent specifications.—ED.]

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 927 Chestnut Street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not egularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternating and Rotary Current Dynamos.—A translation of the paper of Mr. von Dobrowolsky, abstracted in the Digest, March 9 (see also April 20), is published with the illustrations, in the Lond. "Elec.," May 17.

Metals for Magnet Cores.—In a paper by Mr. Barry in "Proc. Cornell Elec. Soc.," Vol. 2, he gives a brief historical sketch of the development of the practical study of magnetism, calling attention to the contributions on this subject emanating from Cornell University, and giving some comparative curves. In conclusion he makes the following general statement among others: At the present time steel is used almost exclusively in field cores, armatures and transformers; it is conceded by the majority of manufacturers that there is a saving of 20 per cent. in the cost of metal in the use of cast steel over cast iron, not including the saving of copper; the consequent reduction of weight of large generators is nearly one half; carbon is the most objectionable impurity in cast steel, silicon being much less objectionable, but forms blow-holes and makes the metal much more difficult to work; annealing cast steel increases the permeability slightly at low densities; silicon prevents the improvement which would otherwise result from annealing; sulphur and manganese in very small quantities were found not to increase the hysteresis loss materially; it is essential to make an analysis of the steel in each casting used; cast steel for field yokes costs from 5 to 6 cts. per pound as against 6 to 7 cts. for its mechanical equivalent of cast iron or 5½ to 8 cts. for wrought iron forminge; it should not contain more than 0.2 per cent. carbon, 0.4 per cent. manganese and 0.2 per cent. of silicon; pole pieces are best made of the finest quality of wrought iron "cast into the yoke"; wrought iron is used to advantage for the field cores of small machines, it is cheaper and more uniform than steel; cast iron can be used only in small machines; sheet steel can be used in armature cores where the number of reversals is below 125 to 150; for transformer cores with a frequency of about 100 the advantages of steel are less marked and it is doubtful if any exist; the hysteresis loss is greatly decreased by lowering the amounts of phosphorus and manganese, and to a certain extent also silicon and carbon; with sheet metal the effect of annealing is most marked; the best composition for sheet steel is about 0.08 per cent. carbon, 0.03 per cent. phosphorus, 0.4 per cent. manganese and 0.01 per cent. silicon; Mitis iron is a good metal for field cores, its disadvantage being its great roughness and the difficulty in working it.

Alternating Current Motors.—A paper of some length by Prof. Ryan is published in "Proc. Cornell Elec. Soc.," Vol. 2; he discusses synchronous, induction and monocyclic motors; the paper is illustrated with polar diagrams and diagrams of machines; it does not admit of being abstracted.

Method of Reducing Hysteresis Loss in Armature and Resistance Loss in Field.—A paper by Mr. Mann on this subject is published in "Proc. Cornell Elec. Soc.," Vol. 2.

New Automatic Regulator for the Brush Arc Dynamo.—In "Elec. Power" for May, Mr. Foster gives a well-illustrated description of the regulator for this series constant-current dynamo.

LIGHTS AND LIGHTING.

Projector Mirrors.—The Lond. "Elec. Eng.," May 17, publishes a translation of a pamphlet recently issued by Sautter, Harlé & Co., of Paris, the makers of the Mangin mirrors, giving a description of them and their properties, and comparing them with the parabolic mirrors; it is thought that the good results obtained by Schuckert (who makes the parabolic form) were attributable rather to the employment of comparatively short focal lengths and to the use of automatic horizontal arc lamps, than to the particular type of mirror, the parabolic; until recently it was thought impossible to construct a Mangin mirror having a focal length of less than two thirds of its diameter, but its makers have now succeeded in reducing it so as to admit of the use of horizontal lamps.

Illumination from Captive Balloons.—According to the "Zeit. f. Beleucht.," May 15, the German government is making some experiments to light areas for military drills by means of arc lights on captive balloons, connected by cables with the stationary generator; the candle-power will be 5,000, which will suffice for illuminating an area 500 metres in diameter; the balloons are 150 to 200 metres above the surface.

New Electrolier in the New Reichstag Building.—An illustration of this elaborately decorated electrolier is published in the "Zeit. f. Beleucht.," May 15; it is over 25 feet in diameter.

POWER AND HEAT.

Heating Metals Electrically.—The "Elek. Echo" for May contains a long anonymous article (apparently written by the inventors) describing in detail the Hoho and Lagrange process and its application to working with metals. This process has already been fully described in these columns but the following additional information may be of interest. (The metal to be heated is dipped into a liquid and a current of great density is passed over it and the liquid which heats the metal.) It is very necessary that the voltage used be regulated and adapted to the different operations, and it is therefore essential that a voltmeter be connected with the circuit; the liquid used must be adapted to the operation to be performed; for low voltages, about 100 volts, and for heating metals, a 20 per cent. solution of potash is best, but for higher voltages, up to about 350, the liquid should be made more resisting; the time of the operation depends chiefly on the voltage and it is economical to use a high voltage in order that the heating is produced as quickly as possible, the loss in the liquid being then less; the current in general does not increase materially with the voltage; in general five amperes per sq. cm. of surface to be heated can be taken as a basis and is about the same for the metals and the liquids; the temperature of the bath has a great effect on the consumption of current, the best temperature is from 50 to 70 degrees C. (122 to 157 degrees F.), as the current and the time are then at a minimum; the time is at most several seconds; the caloric efficiency is between 35 and 50 per cent., depending upon the size of the piece and the voltage, this efficiency approaching 100 the more rapidly the metal is heated. This process is specially adapted to heating to a high temperature particular portions of metals, for annealing, welding, heating, melting and for cleaning the oxidized surface of metals; the applications are considered in detail; most of them have already been described in these columns. They state that iron or steel which has been heated by this method does not oxidize as readily afterwards; steel is welded as easily as iron and either may be welded to copper or bronze; mention is made of official tests conducted by the Belgium government railway department but the results are not given; it is stated, however, that in subjecting iron or steel welds to tension tests they did not break at the weld. A short table of data is given from which the following is extracted: it refers to butt welds of round iron bars, the liquid being a 20 per cent. potash solution at a temperature of 70 degrees C.; for diameters of 10, 20, 30 and 40 the data is respectively as follows: the heated surface is 5, 15, 35 and 60 sq. cm; the voltage 110, 130, 170 and 220, the current for one rod was 20, 75, 175 and 300 amperes, the time 6, 10, 15, and 20 seconds and the horse-power-hours 0.005, 0.04, 0.17 and 0.50. The number of welds that can be made in a day is about double, as compared with what an experienced smith with several assistants could do. Its adaption to making screws, bolts and chains, and for drop forgings, is described, one of its advantages for the former being that steel can be used and that only a portion of the metal need be heated; the time and manipulation saved with drop forgings is said to be very great. It is well adapted to annealing, especially in wire drawing in which the wire is cleaned by the same operation; also the tempering, in which operation it is merely necessary to break the circuit in order to chill the metal in the same liquid in which it was heated; the tempering is said to be very regular and the heating may be localized at any particular part; it is specially adapted to superficial hardening; an interesting application is in the hardening of tires of wheels and the tops of steel rails, which is said to double their life; for such superficial hardening the heat should be generated very quickly; for this operation

the voltage is from 100 to 150 and the current is five sq. cm; for cleaning the surface of oxidized metals, heating should be avoided as much as possible and therefore a lower E. M. F. should be used; for iron pieces containing less than 39 sq. cm of surface 119 volts are sufficient and five to six amperes per sq. cm, according to the degree of oxidation; the time is six to 10 seconds; when the article is connected to the positive pole its surface may be oxidized. Its application in chemical industries are briefly pointed out and it is claimed that operations become possible which formerly were impossible, as the electrolytic, chemical and caloric effects are combined.

Electric Furnaces.—A recent paper by Messrs. Girard and Street describing their new furnace and its application for the transformation of carbon into graphite, is abstracted in "L'Ind. Elec.," May 10; the carbon is converted into graphite by passing the pulverized material across a space heated by the arc; the principle of their furnace is that the arc is made to revolve by the action of a powerful magnetic field; they point out the application of this principle for heating crucibles; they made researches in which they endeavored to apply graphite for the manufacture of incandescent lamp filaments; it is possible that such filaments may be made which will enable the lamps to be forced without reducing their life and without the objectionable feature of blackening of the bulbs during their use; their researches in this direction have not yet been completed.

Power Generation and Distribution near Munich.—The "Elek. Anz.," May 12, contains a brief description of the 2,000-hp station for utilizing the water power of the Isar; it is thought that the whole power will soon be used in factories which it is believed will be located there; in the neighboring city of Thalkirchen electricity is used very largely, particularly for power purposes; the steam threshing-machine will be hereafter run electrically; it is transportable and is carried from house to house, being connected in each case to the circuit of that building.

Application of Electricity in Agriculture.—According to the "Zeit. fuer Elek.," May 15, the Prussian Minister of Agriculture is about to make some experimental tests in order to find whether such applications will give commercially satisfactory results.

Electric Motors in Workshops.—An anonymous article from the French is begun in "Elek. Echo" for May; it is intended to discuss the questions whether it is economical to replace mechanical transmission in existing factories by an electric system, and whether a new factory should be provided with motors or mechanical transmission; the results of some tests in a factory in Middlesbrough, Eng., are given.

Electric Transmission in Workshops.—A recent paper by Mr. Hillairet is published in abstract in "L'Ind. Elec.," May 10; it appears to contain little that is new; he gives the tests of Mr. Compere made two years ago showing the power and efficiency in several different kinds of manufacturing establishments; the efficiencies vary from about 30 to 50 per cent.

Crane.—A description of a method for operating a revolving and traveling electric crane, taken from a German patent, is given in the "Elek. Anz.," May 16.

Windlass.—An electrically-driven windlass, to be used on board ships, is described and illustrated in the "Elek. Anz.," May 12.

A Wheelbarrow Drill.—A convenient apparatus for use in track construction is described and illustrated in the "St. Ry. Gaz.," May 25; it consists of a ½-hp electric motor on a wheelbarrow operating a drill by means of a flexible shaft, the power for the motor being taken from the trolley wire; a hole can be bored through the web of the rail in less than a minute.

Electrical Heating.—The article by Mr. Hadaway, abstracted in the Digest, May 18, is reprinted in part in the "Elec. Age," May 18.

TRACTION.

Ordinances and Regulations.—In the regulations regarding the electric lines in Hamburgh, there is a clause stating that whenever the police department considers it necessary, the cars shall be provided with speed indicators (why not recorders?). In an ordinance granting the right for an electric trolley road in Braunschweig, Germany, there is a clause stating that if at any future time, in any German city of the same size, an underground conduit system is shown to be indisputably better than the trolley system, it must be substituted for the trolley road at Braunschweig.

Electric Locomotive Factory.—According to the "Elek. Anz.," May 12, a special factory is being built at the works of Brown, Boverie & Co., Baden, Switzerland, for the construction of electric locomotives.

Conduit Systems.—"L'Energie Elec.," May 16, publishes at some length an illustrated description of the Hoerde system (described in the Digest, March 30), including an illustration showing the contact shoe.

Comparative Value of the Rheostat and Series-Parallel Method.—"Elec. Power" for May contains an article by Mr. Sever in which he describes and gives results of tests to enable a comparison to be drawn between the two distinct methods of car control under widely varying conditions, in crowded city districts and on long runs with infrequent stops; he believes the figures given can well represent the average service. The cars were operated like those in regular use only that the load was constant; the tests were made on the Coney Island & Brooklyn Railway; he describes the methods and instruments used and gives the results in the form of a large number of curves. One of his conclusions is that there is a gain of over 40 per cent. in the power used, in favor of a one-motor car over a two-motor car with the K controller; in a comparison of the efficiencies he shows the great gain of the series-parallel controller over the rheostat in city work where stops are frequent, the saving being from 45 to 50 per cent.; the one-motor car shows a result a little better; in a district where the stops are less frequent the superiority of the controller is still shown but in less amount, being about 33.33 per cent. in the saving of energy; the one-motor car shows a gain of almost 50 per cent. over the rheostat and about 15 per cent. over the two-motor cars; in the run between the Boulevard and Coney Island the saving of the two-motor car is 10 per cent. and that of the one-motor car 42 per cent. over the rheostat and 32 per cent. over the two-motor car.

Mechanical Equipment of Power Stations.—The "Proc. Cornell Elec. Soc.," Vol. 2, contains a paper of some length by Prof. Carpenter; it is interesting in giving information and advice but does not admit of being abstracted; it refers merely to the mechanical part of power stations for electric railways. In the order of their importance, he gives the three important requisites as follows: reliability and certainty of operation, uniformity of speed, and economy; he does not recommend the line shaft system; the direct belt system is the cheapest in the first cost and in many respects the most satisfactory to operate, but the direct connected system he considers the ideal one; the cost of it, however, is about 20 per cent. over the direct belted system; he prefers the English practice in which the engine shaft is connected to the dynamo with a coupling, to the American practice of suspending the armature on the end of the shaft; the lowest first cost is attained by making the units of the largest size and fewest number, as it is more economical to run an engine with an underload; the ideal station should have about three units and one relay; it is not advisable to use a generator smaller than 100 kw. He discusses water motors, heat engines and steam engines, particularly the former, concluding with a table of steam consumption per horse-power-hour for different classes of engines, which was published in "Trans. A. I. E. E."

Conduit vs. Trolley.—The long serial by Mr. Sachs is concluded in "Elec. Power" for May; he gives briefly the general conclusions arrived at. He believes that an operative conduit system can no doubt be produced, but the first cost is quite serious; a desire to produce a cheap system has no doubt been the cause of past failures; he believes that the cost would be less than that for a cable system while it would be equally efficient in operation; he recommends the use of low voltage down to 150 to 200 volts; the alternating current would lend itself readily if suitable motors existed; with very low voltages it may be possible to operate some form of closed contact system if the switching-off of the surface conductor can be absolutely insured; he believes the solution of the problem is dependent on engineering skill and that a practical and operative system can be developed from the material already tried, but unless some new departure is made in the methods of distribution he believes the solution will be confined to the open-slot, continuous-wire conduit.

Three-Phase Railway Plant.—The "St. Ry. Gaz.," May 25, gives a brief description of the system for the Dalkey line of the Dublin Southern Company in which both three-phase and continuous currents are to be used; on account of the length of the line and other considerations several secondary feeding stations are erected along the line, the power for these being supplied from the main station by means of a high tension, three-phase alternating current; the current for the line is the usual continuous current; the voltage of the three-phase circuit is 2,500 to 3,000 and the frequency is 30; there are two three-phase machines of 120 kw each; the two motors at each of the sub-stations are synchronous and have a capacity of 60 kw each; the synchronous motors may be started either from the three-phase circuits or from the trolley wire.

Alternating Current Railway System.—The "St. Ry. Gaz.," May 25, gives a brief description of a system patented to a Mr. Strong in which three-phase alternating currents are used on the car. There are two trolley poles and wires, the rails forming the third circuit; the principal feature is the regulation of the motors, which is described in detail.

Test of an Electric Snow Sweeper.—An abstract of a thesis by Messrs. Crumb and Stocking is given briefly in "Sibley Jour." for May. The sweeper tested was built by the General Electric Company and is used in Elmira, New York; the results are given in the form of two sets of curves, one showing the electical horse-power supplied to the truck and the other that supplied to the brush motors; the latter shows quite a steady consumption while the other, the truck motor curve, shows considerable fluctuation owing to the different depths of snow and the irregularity in the running of the sweeper; the length of the run was five miles.

Test of Ithaca Street Railway Power Plant.—An abstract of a thesis by Messrs. McNeil and Manning, giving the results of a test in detail, is published in "Sibley Jour." for May; the test seems to be limited to that of the boiler and engine, very little being said regarding the electrical part and nothing regarding the line or cars.

Accumulator Traction in Paris.—Some additional data of the paper of Mr. Sarcia, abstracted in the Digest last week, is published in the "St. Ry. Gaz.," May 25; one of the cuts showing how the batteries are inserted into the car is reproduced.

Pittsburgh.—An illustrated description of the Schenly Park & Highlands Railway is published in the "St. Ry. Gaz.," May 25.

Litigation Concerning the Underground Trolley.—"El'ty," May 29, publishes at some length the records of the final hearing of the litigation between the General Electric and the Westinghouse companies, the main points of which were given in THE ELECTRICAL WORLD two years ago.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Train Lighting.—A recent paper by Dr. Buettner is abstracted briefly in the "Elek. Zeit.," May 16. The original contains descriptions and comparisons of the principal systems at present in use. Among other things he states that the weight of the apparatus, when gas is used, is much greater than that for the electric system, for the same illumination; results obtained have shown that the cost of operating is appreciably less for the electric system; on three of the lines the cost of the installations on the cars, using accumulators, is equal to that for gas, while that for the stationary part of the installation is appreciably higher for gas; for a gas plant for 170 cars, the latter is about 50,000 marks (about $12,500), while that for a charging station by the electric system of equal capacity is 25,000 ($6,250), with the additional advantage that this plant can be used for lighting the stations and the road; the cost of the electric system is therefore appreciably less especially for small lines.

Street Lighting by Series Incandescent Lamps.—The Lond. "Elec. Rev.," May 17, gives briefly a summary of what has been done in this direction; it also contains a communication pointing out the disadvantages of the Parfitt system, which was described in the Digest last week.

Accumulator Stations.—A description, taken from a German patent specification, of a new method of connecting the dynamos in a three-wire accumulator system in which only one large generator is used in connection with several smaller ones, is published in the "Elek. Anz.," May 16.

Railroad Installation.—A recent paper by Mr. Bochet on the electrical installation at a new railroad station in Paris is given in "L'Ind. Elec.," May 10; at this station, which is at the end of the new prolongation of the Sceaux railway, electricity will be used for many different purposes, but, strange to say, not for traction through the tunnels under the city street.

Sheltenham.—A very long and well-illustrated description of this municipal alternating-current station is published in the Lond. "Elec. Eng.," May 17; the station is near the existing refuse destructor, the steam generated by the necessary destruction of the house rubbish being enough to run the engines during the lightly loaded periods of the day. A brief description is published in Lond. "Lightning," May 16.

St. Pancras.—A brief description of the accounts of this station is given in the Lond. "Elec. Rev.," May 17; it criticises unfavorably the item of depreciation which it is believed was put too low.

Budapest.—The description by Mr. de Fodor is concluded in the "Zeit fuer Elek.," May 15.

Loads for Central Stations.—"Elec. Power" for May contains a second article by Mr. Perry on "Working Out Its Own Salvation," in which he describes a number of ways in which a profitable day-load may be provided for central stations. He describes the Hall process for obtaining aluminium, the manufacture of soda and bleaching powder, the production of carborandum and calcium carbide, the latter being discussed at some length including some estimates of the cost of a plant; the patents regarding the latter material are briefly discussed, and belief is expressed that it is extremely doubtful if they are worth anything at all and that they afford no protection whatever to the inventor; it is stated that not an ounce of carbide was made by the inventor until long after the patents had been issued. In conclusion he states that he does not suggest to the central station manager to undertake these industries himself as that would in many cases be impracticable, but he recommends that inducements be offered to others to locate near to the station and to use in this and other ways the surplus energy at a figure less than they could themselves produce it for, and still at a figure which would net the central station a small profit during the hours when the machinery is bringing worse than no returns.

Pennock Electric System.—The "Sibley Jour." for May contains a short article by Mr. Swann in which he gives a brief account of the Pennock system and describes tests made at the Cornell University. In this system the same current is switched successively to different lamps and motors, the claim being that a large number of them can be run by the same current without increasing the amount of energy required; the tests show that the candle-power diminishes with the time during which they have current, and that therefore the claims are not substantiated.

WIRES, WIRING AND CONDUITS.

Earthing.—In a communication by Mr. Andrews in the Lond. "Elec.," May 17, he comments favorably on a recent report (see Digest, May 18 and June 1), stating that the advantages are even greater when a two-wire system is earthed, whether continuous or alternating currents are used; feeders should be insulated up to the feeding point; the earthed conductor of the network (mains) should be uninterrupted by fuses or switches throughout; with continuous currents the negative should be insulated to a slight degree to provide against electrolysis and be earthed at each feeding point and house connection; if alternating currents are used the insulation of the earthed conductor is not a necessity; if concentric cables are used the earthed connections may be omitted; to reduce the voltage between different points on the earthed conductor the extreme ends of the branches should be connected together and, where possible, back to the mains; both wires in the houses should be well insulated except with the concentric system, and the fuses and switches should be inserted only in the non-earthed conductor. He has had sufficient experience with earthed systems to be able to say that interference in telephone and telegraph circuits is at least no greater and the same may be said with regard to electrolysis.

Underground Conduits and Cables.—In a continuation of Mr. Maver's article in "Elec. Power" for May he gives an illustrated description of a number of solid conduit systems and some bare wire conduits.

Fuse Wire.—A summary of a paper by Mr. Matthews is given in the "Proc. Cornell Elec. Soc.," Vol. 2; it was published in full in the "Trans. A. I. E. E.," Vol. 10, p. 250.

ELECTRO-PHYSICS AND MAGNETISM.

Light and Electrification.—The Lond. "Elec. Eng.," May 17, gives a brief summary of an article by Prof. Lodge in the current number of "Science Progress"; it treats of the subject of photo-electric action, the influence of illumination on electrified surfaces. Among other things he states that the order of metals in their photo-electric power, when tested by their discharging action for negative electricity, is the same as their order in the voltaic series; the facts discussed suggest some chemical or semi-chemical explanation. Regarding the effect of magnetism, he discusses the observations of Elster and Geitel who found that if the lines of magnetic force had the same direction as those of electrostatic force, they had no appreciable influence on the discharge power of light, but as soon as they cross each other the discharge power of light was diminished and interfered with.

New Method of Magnetizing.—A method of magnetizing scythes by Mr. von Wieser is described in "Zeit. fuer Elek.," May 15. The dynamo consists of a bipolar machine having an H form of armature as in the primitive forms of dynamos; the ends of the single coil are connected to a coil surrounding a laminated magnet which is secured to the end of the shaft and rotates with the armature; the scythe to be magnetized is held in front of the poles of this magnet; for each half revolution of the magnet the current will be reversed and the equivalent of the whole apparatus will therefore be that of a fixed magnet having a fixed but strongly pulsating field; the magnetization of the scythe is said to be much greater on account of the intermittent character of this magnetizing field. In another method the scythes are moved rapidly to and from the poles of a fixed magnet.

Curious Vacuum Tube Phenomena.—Referring to the experiments of Mr. Lomas (see Digest last week) Mr. Taylor in the Lond. "Elec.," May 17, states that he has often noticed the after-glowing, and thinks the explanation is not obscure, both the shock and the glow being due, he believes, to the discharge of the accumulated electrostatic strain in the glass; to show this an experiment may be made with a plate of glass without conducting coatings, which is charged by holding it between the poles of an influence machine; the discharges between the knobs will continue until the plate is fully charged; it may be discharged by placing a sheet of tin foil on each side and connecting them; he believes that the electrostatic capacity of the vacuum tubes is not at all inconsiderable on account of the amount of surface and thinness of the glass.

Alternating and Interrupted Electric Currents.—Prof. Forbes' second lecture is continued in the Lond. "Elec. Eng.," May 17, including several of the illustrations. His third lecture is abstracted in the Lond. "Elec. Rev.," May 17; the abstracts of these lectures in the latter journal, although apparently not so complete, contain better descriptions than what appears to be a stenographic report, in the former. In the third lecture a good explanation is given, with references to the original statements of the fact that the same quantity of electricity passed through wire in succeeding impulses, separated by a period of rest, heats it more than if it passes through as a continuous current.

Molecular Volume.—A lecture by Prof. Roberts-Austen, on researches with alloys, mentioned below, is abstracted briefly in the "Eng. & Min. Jour.," May 25. One of the experiments was as follows: With the aid of a Planté battery he made sodium pass from sodium amalgam through a sheet of glass several millimetres thick and enter mercury placed on the other side of the glass; the temperature of the whole was 200 degrees C.; when lithium amalgam was subsequently substituted for the sodium, the metallic lithium passing through the glass partly forced out the sodium; the conclusion from this is that atoms of lithium can pass along the tracks left in the glass by the sodium atoms; when a metal of atomic weight and volume superior to sodium was substituted,

such as potassium, it was found impossible to replace the sodium, the atoms being too large to pass through the space where the sodium had been; there is therefore a molecular porosity which can in a sense be gauged and the mechanical influence of the volume of the atom is made evident.

Capacity of Electrolytic Condensers.—The "Phys. Rev." for May-June contains an article of some length by Messrs. Sheldon, Leitch and Shaw, in which they give the results of extended measurements and investigations. An electrolytic cell when subjected to small voltages acts as a condenser of great capacity; in the present paper the properties of such a condenser are examined and discussed. They describe the method of measurement which in general is to find the throw of the galvanometer corresponding to the quantity of electricity necessary to depolarize the cell from a given voltage to zero, plus the quantity necessary to polarize it to the same voltage in the opposite direction; the capacity at that voltage is obtained by dividing half the quantity by the voltage. They discuss the effect on the capacity of the E. M. F., the electrode surface, the temperature, concentration and coupling of cells; they also discuss the dissipation of the charge, obtaining curves which are very similar to hysteresis curves.

Differences of Electrical Potential between Substances in Contact.—The "Proc. Cornell Elec. Soc.," Vol. 2, contains a paper by Mr. Child in which he discusses the discoveries made in this field, shows the connection between them and gives the arguments on both sides concerning the seat of the E. M. F.; he gives a general idea of how the subject stands to-day rather than a full and impartial history.

Metallic Conduction and the Influences which Affect It.—The "Proc. Cornell Elec. Soc.," Vol. 2, contains a long paper by Mr. Rogers in which he gives a summary of what is known of the influences affecting electrical conduction in metals, with a brief statement of the theory of electrical conduction.

Thermal Conductivity of Copper.—An article by Messrs. Quick, Child and Lamphear, is begun in the "Phys Rev." for May-June; the temperature and the electrical resistance were measured electrically; the article contains tables of data of the results.

Records of Electric Discharges.—The "Elec. Rev.," May 29, publishes an article from the "Literary Digest" by Mr. Karyll; it reproduces four microscopic enlargements of discharges made on a plate of smoked glass, held between two terminals of an induction coil.

Secular Motion of a Free Magnetic Needle.—A reprint of the paper of Mr. Bauer recently read before the National Academy of Science, is begun in the "Phys. Rev." for May-June. It appears to be similar to the one mentioned in the Digest, April 27.

Resonance in Transformer Circuits.—The "Phys. Rev." for May-June contains an analytical and graphical treatment of the subject by Messrs. Bedell and Crehore.

Electrical Resonance and Some Allied Phenomena.—Portions of a paper by Dr. Bedell are published in "Proc. Cornell Elec. Soc.," Vol. 2.

ELECTRO-CHEMISTRY AND BATTERIES.

Chemical Reactions in Accumulators.—Mr. Darius begins a series of articles in "L'Elec.," May 18. In the double sulphating theory of Gladstone and Tribe and of Mr. Steintz (probably Streintz, see Digest, Jan. 19), it is assumed that metallic oxides cannot exist in the presence of a free acid; if it can be shown that this is incorrect the double sulphating theory cannot be correct; he then shows that oxides of lead can exist perfectly in the presence of sulphuric acid; in general if acid acts on an insoluble oxide the product being itself insoluble, the action is never complete; he gives the results of experiments with litharge showing that in a two days' immersion it was only about half converted into sulphate, the amount varying with the concentration of the liquid; the same is true, though to a less extent, with the oxide on a positive plate; he concludes that it is therefore not correct to introduce into the thermo-chemical calculations the heat of formation of sulphate of lead on the positive plates; the sulphate found on this plate after a discharge is always variable in quantity and is due only to the local action of the acid on the oxide reduced from the peroxide, and it never is included in the principle reactions of the discharge.

New Product of Lead.—According to "Elek. Anz.," May 12, Hannay noticed that if sulphate of lead is added to molten galena a dense smoke containing lead will be produced; it will also be generated whenever galena is roasted in an atmosphere containing oxygen or gases containing oxygen (possibly there might be an application of this finely divided lead compound, in accumulators).

Reduction of Refractory Metals.—A recent Society of Arts lecture by Prof. Roberts-Austen is abstracted in the Lond. "Elec.," May 17; brief references are given to electrolysis and the use of electric furnaces, attention being called to the fact that in the latter carbides of great stability are formed from which the pure metal can be obtained only by repeated fusion with the oxide of the metal under treatment.

Purification of Drinking Water.—The Lond. "Elec. Rev.," May 17, calls attention to a paper by Mr. Oppermann in the "Elek. Rund.," 12, p. 42 and 50, in which he describes a process in which the ozone is used to oxidize organic matter in water, and convert nitrites and ammonia into nitrates; an excess of oxygen gives the water an unpleasant taste which however disappears on standing from one to two weeks; hydrogen dioxide is also produced, and as it is an undesirable constituent he subjects the water to a second electrolysis, using aluminum electrodes which form aluminum hydro-oxide, and after filtration the water is fit to drink; the most suitable conditions for the production of ozone in the electrolysis of water are a temperature below five or six degrees C., small platinum electrodes and a high current density, under such conditions the gaseous product contains about six per cent. of ozone. A similar paper by the same author was abstracted in the Digest, May 4.

Electrolysis of Cuprous Chloride.—The article abstracted in the Digest, May 11, under "Metallurgy of Copper," is translated in abstract in the Lond. "Elec.," May 17, in which the illustration is also given.

Cyanide of Potassium and Electricity.—The Lond. "Elec. Rev.," May 17, contains an article by Mr. Andreoli in which he comments on the decision in the recent litigation regarding the gold extraction process.

Gold Extraction.—A description of the public trial made recently of the Haycraft process, is published in the "Eng. & Min. Jour.," May 25; in this process ordinary salt is decomposed by the current, the sodium passing to the mercury and the chlorine dissolving the gold, the chloride of gold being electrolyzed and the gold deposited on the mercury; the cost of the treatment including crushing is estimated at about 7s. 6d. per ton.

Modern Theories of Primary Batteries.—In a paper by Prof. Merritt published in the "Proc. Cornell Elec. Soc.," Vol. 2, he discusses some points in connection with the theory of electrolysis; it does not admit of being abstracted.

UNITS, MEASUREMENTS AND INSTRUMENTS.

New Method for Measuring Specific Inductive Power.—In "L'Elec.," May 18, Mr. Nodon describes methods which he used in connection with Prof. Pellat. Two metallic spheres of small capacity are placed at some distance apart and connected with a high-potential source of variable currents, such as an induction coil; a third and movable sphere is grounded through a telephone; when this sphere is moved between the other two, a position will be found at which there will be no sound in the telephone; a slab of the dielectric to be tested is then placed between the movable and one of the other spheres, then the position of the movable sphere must be altered in order that no sound be heard in the telephone, the movement being toward the dielectric; the distance through which this sphere was moved will then be proportional to the specific inductive power of the dielectric. In order to standardize the apparatus a material of known inductive capacity is first used, the specific inductive capacity of the unknown material being then obtained in terms of this standard, the two specific inductive capacities being directly proportional to the two distances (from the centre as found in the first test) measured in the two tests. This method may also be used for liquids and gases by placing them in tanks with parallel sides, made of a dielectric whose inductive power has first been determined. The method is said to be very simple and precise.

Measuring Armature Loss and Efficiency of Motors and Generators.—The "Elek. Zeit.," May 16, contains a long communication from Mr. Lenz and an answer by Mr. Grau concerning the discussion which has been going on for some time (see Digest, Dec. 1, March 9, March 23); both letters refer chiefly to personal matters and contain little of general interest; by order of the editors the discussion is herewith closed.

Submarine Cable Work.—In the continuation of Mr. Wilkinson's serial in the Lond. "Elec.," May 17, he discusses the polarization of fault or break, the improved Blavier and the Mance partial earth tests.

Universal Electro Dynamometer.—A good description, with illustrations of the Zickler instrument, described in the Digest, May 4, is published in Lond. "Elec.," May 17. In commenting on it editorially it is believed that this is one of the most successful attempts to produce a single instrument which can be used as an ammeter, voltmeter and wattmeter; it is a question however whether in adopting it to so many different functions a sacrifice of convenience has not been made which will more than counterbalance the advantages; the sacrifice to compactness is believed to have been carried too far; in making the instrument read to 100 amperes, the torsion spring must be somewhat powerful which demands a large turning moment and therefore a large self-induction for the voltmeter coils.

Zero-Torque Meter.—An illustrated description of the Edmondson meter is published in the Lond. "Elec. & Elec. Eng.," May 17. It consists of a dynamometer combined with a mechanism for measuring and integrating the torque exerted on the moving coil by the current to be measured; the motion of the coil is limited to an arc of less than one degree; a torque of about 90 degrees is given to the usual spiral spring every two minutes by a reciprocating quadrant driven by a vibrating motor consisting of a magnet and its armature, the motor being controlled by a small gravity-driven pendulum starting automatically and having a sparkless contact.

Registering Ampere and Voltmeters.—The Hartman & Braun form is illustrated and described in "L'Energie Elec.," May 16; the measur-

ing instrument is a simple Kohlrausch apparatus consisting of a solenoid and a movable core suspended by a spring, the core being drawn into the solenoid; its position is registered on a revolving drum.

Kelvin Volt and Wattmeters for Central Stations.—"L'Ind. Elec.," May 10, contains an illustrated description of these instruments.

Apparatus for Measuring Spherical Intensity of Light.—A good description with illustrations of the lumen-meter of Mr. Blondell, is published in "L'Ind. Elec.," May 10; a description of this apparatus was given in the Digest, April 13.

New Method for Testing the Magnetic Properties of Iron.—A short article by Mr. Franklin is published in the "Phys. Rev." for May-June; he describes the method for the determination of $\mathfrak{B}$ and $\mathfrak{H}$, as follows, giving the proof and experimental results: "A rod, of sectional area q, of the iron to be tested, is bent into the form of a long narrow Ω, and suspended from the (left) pan of an ordinary balance. The legs of the Ω are surrounded by longer stationary coils, each having n turns of wire per centimetre, these coils being connected as the two coils of a horseshoe magnet. The balance is tared, a weight equal to F dynes placed on the right pan, and the current in the coils is slowly increased (or decreased) until the balance is in equilibrium, when the current, i, is measured; then

$$\mathfrak{H} = 4\pi n i$$

and

$$\mathfrak{B} = \frac{2\pi F}{q H} + \mathfrak{H} \ .$$"

He describes the method for the direct determination of hysteresis loss as follows, giving the proof and experimental results: "The iron to be tested is taken in the form of a long straight rod, and suspended vertically from the pan of a balance. A coil of wire of medium length, of n turns per centimetre, surrounds the rod, and is arranged so that it can be moved up and down conveniently. It being required to find the energy loss per cubic centimetre of iron during a cycle in which the magnetizing field changes from $+\mathfrak{H}$ to $-\mathfrak{H}$, and back to $+\mathfrak{H}$ again, a measured current i is passed through the coil. The coil is moved up and down over the whole rod a number of times, the current being reversed each time the coil reaches top or bottom, until the changes in the rod have become cyclic. The rod is then weighed down during the upward motion of the coil, and during the downward motion of the coil. Let F be the difference of these two weights in dynes; then

$$W = \frac{F}{q}$$

in which q is the sectional area of the rod, and W is the energy per cubic centimetre lost in the iron in one cycle. The magnetizing field is calculated from the first equation given above."

Measurement of Electrical Resistance.—In a short article by Mr. Parker in "Elec. Power" for May, he discussed the present range and accuracy in such measurements. From theoretical and practical considerations he places the limits at one ten-millionth of an ohm and ten million million ohms, that is, a range from one to one hundred million million million; he makes comparisons with other physical magnitudes and their measurements. He believes that the greatest accuracy is obtained in the comparison of standard ohms by the Carey-Foster method in which an agreement of results to even .001 per cent. may be reached.

Evolution of a Connected System of Units.—"Elec. Power" for May contains an article by Mr. Wolcott on this subject; he calls attention to some salient facts and the fundamental principles underlying them, which throw light on the general development of units to the present time and which ought to guide one in future work; he deals with units in general and not exclusively with electrical units; he points out some objections to the electrical system and states that even if a logically consistent system, which is practically convenient, could be framed, there would be great difficulty in introducing it.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Electrical Communication with Light Houses.—An abstract of some length of the third report of the Royal Commission is published in Lond. "Elec.," May 17; brief abstracts are given in the "Elec. Rev." and "Elec. Eng.," May 17. It describes the progress which has been made toward carrying out the recommendations made in former reports; the results arising from the work already completed are recognized by the committee as being most valuable.

Railroad Signal.—An improved control signal is described by Mr. Prasch in the "Elek. Zeit.," May 16; the improvement consists in adapting a formerly described apparatus so as to make it possible to have the batteries at the station, instead of locally along the line.

Fundamental Principles of the Telephone.—A lecture by Mr. J. Berliner is abstracted briefly in the "Elek. Zeit.," May 16.

Development of the Telephone.—A recent paper by Mr. Vollmer is given in abstract in the "Elek. Zeit.," May 16.

Muirhead vs. Commercial Cable Co.—According to Lond. "Elec.," May 17, the long litigation regarding the American Duplex patents has been decided in favor of Muirhead.

MISCELLANEOUS.

Method of Finding Flaws in Rails.—The method of de Place, which is used by the Northern Railway of France, is briefly described in the "Elek. Zeit.," May 16; the description, however, is not as clear as might be desired; the microphone is used; the description is taken from "La Revue Technique," April 10, 1894.

Electric Safety Lock.—"La Nature," May 18, contains an illustrated description of a new form of a door lock.

School for Electrical Mechanics.—The programme of a school started last September in Vienna, is published in the "Zeit. fuer Elek.," May 15.

Exhibition of 1900.—Mr. Claude in an article in "L'Ind. Elec.," May 10, suggests that the hydraulic power of some of the numerous falls of the Seine be transmitted electrically to the Exhibition, referring particularly to a falls about six miles from Paris where 1,800 hp could be obtained; the total power of that river which could be obtained even at low water is 30,000 hp; he suggests that this be used at the exhibition for operating fountains and other attractive water effects; the 1,300 hp transmitted would operate a fountain over 60 feet high with a capacity of more than 3,000 litres (800 gallons) per second.

International Exhibition.—According to "Elek. Anz.," May 16, there will be an international exhibition in Kioto, Japan, during four months of the present summer.

Physiological Effects of Alternating Currents.—"Elec. Power" for May contains an article by Mr. Gutmann in which he describes in detail the sensation experienced by himself when by accident his body was directly connected in the high-tension circuit of an alternating current; the voltage of the dynamo was 1,100; after momentary unconsciousness he found himself unable to breathe, cry or move, until accidentally released by an opening of the circuit. He states that the conclusions of Dr. Goelet that death is painless because electricity travels faster than the nerves can transmit painful impulses, seem to him to be erroneous as he believes that three times the number of alternations, as used at present, can still be clearly distinguished by the brain.

Biographical.—A biographical sketch of Mr. A. Langstaff Johnston with portrait is published in the "St. Ry. Gaz.," May 25. The "Elec. Rev.," May 29, publishes a short biographical sketch, with portrait, of Dr. Duncan.

Projectors of the Atlantic Cable.—"El'ty.," May 29, publishes a reproduction of the painting recently presented to the New York Chamber of Commerce.

Electricity in Mining.—In a short paper by Mr. Sanderson published in the "Proc. Cornell Elec. Soc.," Vol. 2, he gives results of tests made by him a year ago of two plants in coal mines.

Lightning Arresters.—In a paper by Mr. Hewitt, published in the "Proc. Cornell Elec. Soc.," Vol 2, he gives a historical sketch of lightning arresters with special reference to those of Mr. Wurtz and his theories concerning them.

New Book.

MOTIVE POWERS AND THEIR PRACTICAL SELECTION. By Reginald Bolton. New York: Longmans, Green & Co. 257 pages. Price $2.25.

The object of this work is to guide the engineer and others in the selection of a motive power suited to specific conditions. To this end a compilation is made of the various facts necessary to settle the question of proper selection, the data being condensed and arranged for the easy reference of engineers, and also put in such a form as to be useful to the non-technical seeker for information on the subject.

All of the various sources of motive powers are considered—human, animal, wind, water, steam, gas, oil, hot air and electricity—and the principal practical data of each given, though electricity is rather summarily treated. Steam engines and turbines naturally receive the most attention, but considerable space is devoted to oil engines, which are viewed by the author with considerable favor.

As an example of the method of treatment we will refer to the subject of water power. To start out, a table of the relative efficiencies of different forms of wheels, turbines, jets, water engines and rams is given followed by tables of hydraulic data, instructions for the measurement of streams, directions as to what data is necessary for determining the most appropriate type and size of wheel for a given case, etc. Next are tables and data in regard to the size and cost of pipes, and then follow two chapters on tidal action and floating wheels. The two concluding chapters on this subject are on the Pelton wheel and turbines, full data being given with respect to the latter on efficiency, capacity and cost.

While the treatment of the various subjects is necessarily meagre, the book contains much data gathered from many sources, and will prove useful as a reference book for the busy engineer and of particular assistance to the non-professional man who desires practical and definite information as to the cost and selection of the best motive power for a given case.

The Brush Company and the Swan Lamp.

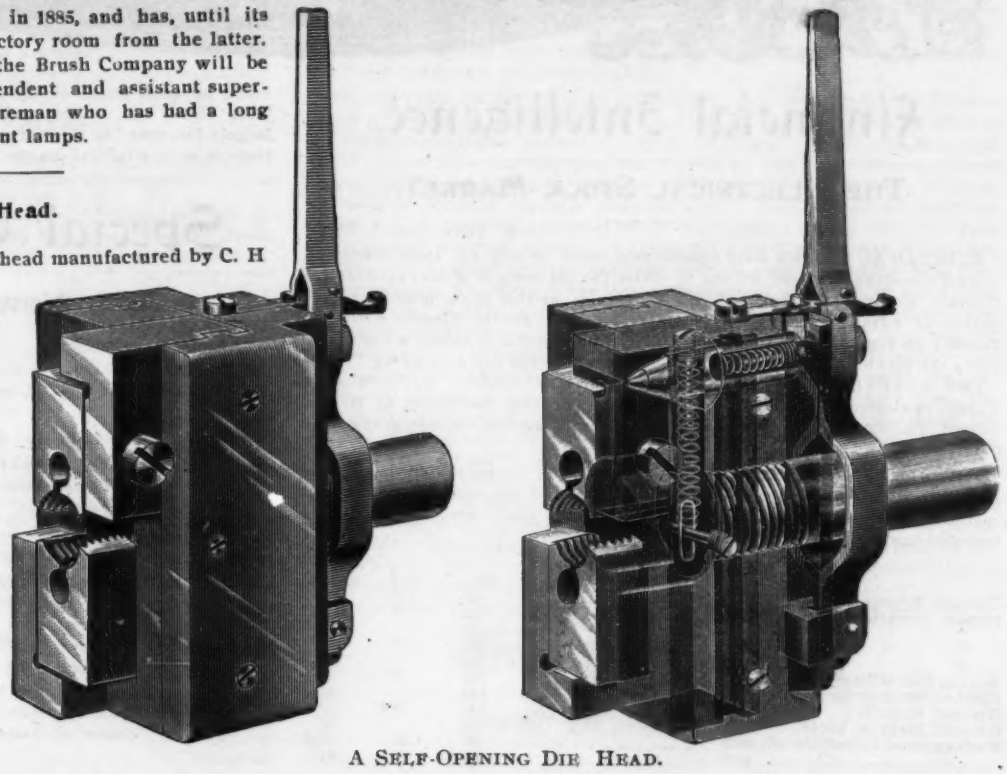
The Brush Electric Company, Cleveland, O., has recently purchased the property of The Swan Lamp Manufacturing Company, and will manufacture and sell incandescent lamps. The Swan lamp is well known throughout the trade, not only because it bears the name of the celebrated English electrician, Joseph Swan, but because of its intrinsic merits.

The Swan Lamp Company was organized in 1885, and has, until its purchase by the Brush Company, rented factory room from the latter. The new incandescent lamp department of the Brush Company will be under the direct supervision of the superintendent and assistant superintendent, but will be operated by a foreman who has had a long experience in the manufacture of incandescent lamps.

An Automatic Die Head.

The accompanying engravings show a die head manufactured by C. H Besly & Co., 10 and 12 North Canal Street, Chicago, for use on screw machines, etc., which is made to open automatically at any desired point, and yet is so arranged as to hold the dies very firmly while cutting. The special feature by which this solidity is secured consists in placing each die upon a sliding block, which extends over and has a bearing the full length of the head, the two blocks being placed side by side in the head.

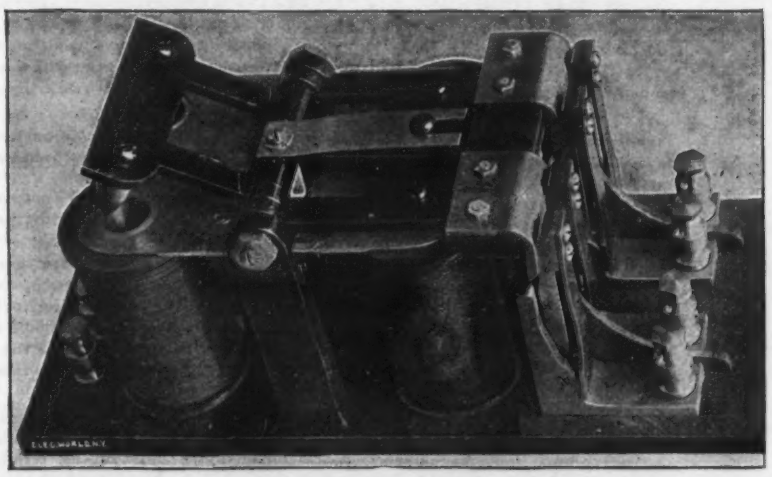
The dies are closed by a taper pin, which is forced into the slides by the lever shown, and when the lever is forced back by a suitably arranged tappet, the dies open quickly by the action of a spiral spring. There are comparatively few working parts in the head, and the long bearings of the sliding blocks insure good wearing qualities. It is said that these dies will cut threads true to size, will do fine, close work, and will not clog with chips. They are made in four regular sizes, to cut screws from the smallest to 1¼ in. diameter.



A SELF-OPENING DIE HEAD.

A "Long-Distance" Switch.

The illustration below shows a compact switch for controlling heavy current circuits from a distance. The device is manufactured by Edwards & Co., Fourth Avenue and 144th Street, New York City, and consists of two heavy electromagnets mounted side by side, with their armatures attached to opposite extremities of a lever pivoted in the centre, one end of which forms an obtuse angle with the other. Contact pieces are carried at one end of the angular lever which complete the circuit across metallic terminal springs when the contact end of the lever is down, and *vice versa*.



ELECTROMAGNETIC SWITCH.

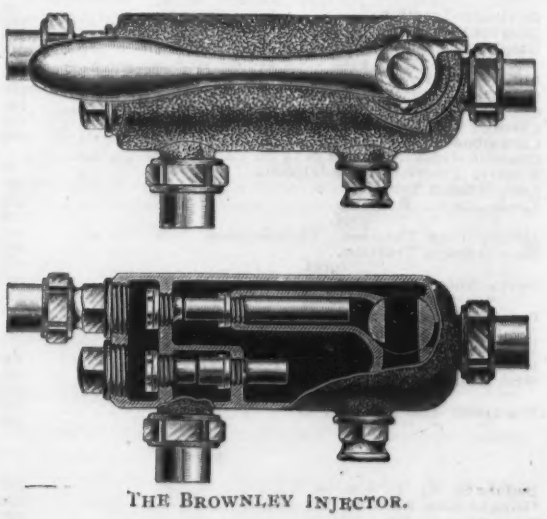
Referring to the engraving, it is obvious that energizing the right-hand magnet results in closing the circuit at the switch contacts, and energizing the left-hand magnet produces the opposite result. It is equally clear that the device may be operated from any reasonable distance, and by means of battery currents or directly from a constant-current lighting circuit.

The switch is a double-pole, double-break device, and the contacts and conducting pieces are liberally proportioned so as to avoid any undesirable results from heating.

A New Automatic Injector.

We illustrate herewith a new injector, known as the "Brownley valveless," which is being marketed by Edward F. Keating, of 189 Cherry Street, New York, and for which some very strong claims are made. The injector is a double-tube machine, and is very simple in construction. An ordinary mechanic can take it entirely apart and put it together again in five minutes. To start the injector, steam is given, when water will immediately appear at the overflow. The lever on the side of the machine is then turned at right angles to its position when starting, and the water is shut off from the overflow and fed into the boiler. An inspection of the lower accompanying cut will make this clear.

It is claimed that this injector will start at 15 pounds pressure and work up as high as 350 and down as low as six pounds, without breaking and without requiring any regulation whatever.



THE BROWNLEY INJECTOR.

There are no valves to regrind, the flow of water being controlled by the plug cock shown in the engraving. In a test made by the general foreman of the Manhattan Railway Company, the Brownley injector is said to have fed about 33 per cent. more water in a given time than a machine of a well-known make, of the same rating. The Brownley locomotive injector is slightly changed in form so as to make the fittings interchangeable with other types and simplify the substitution of these machines for other makes.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, June 1, 1895.

ELECTRICAL STOCKS were notable this week chiefly for their inactivity. Notwithstanding sporadic efforts to revive the old story of a deal between the General Electric and Westinghouse companies, neither stock manifested any particular advance or reaction. Traders bid up General Electric a little on Tuesday on vague reports that the company would probably obtain a contract to equip the Manhattan Elevated, but lack of confirmation had a "staying" effect.

THE MUTUAL TELEGRAPH COMPANY, a leased tributary of the Western Union, re-elected its old Board of Directors on Tuesday, consisting of Messrs. Eckert, Van Horne, Gould, Moore, Sage, Schley, Chapman, Gallaway, Page and Calef.

THE WEST END STREET RAILWAY COMPANY'S earnings on Decoration Day were $29,000—the largest known in the history of the company. Universal comment was made concerning the exceedingly small number of accidents recorded against the company.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	99	101
" " " Brooklyn	100	..	108
" " " Boston	100	129	130
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	..	27¾
General Electric	100	35⅛	35⅜
General Electric, pref	100	..	65
Westinghouse Consolidated, com.	50	32	32⅛
" " pref	50	52	52½
BONDS.			
Edison Electric Ill., New York	100	105⅛	105⅛
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	202	203
American District Telegraph	100	30	40
American Telegraph & Cable	100	94½	..
Central & South American Telegraph	100	117	120
Commercial Cables	100	150	..
†Erie Telephone	100	57¼	57¾
Gold & Stock Telegraph	100	105	..
New England Telephone	100	..	72
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63½	..
Western Union Telegraph	100	92¼	92½
ELECTRIC TRACTION STOCKS			
Baltimore Traction	25	18¼	18½
Binghamton RR. com	100	100	..
Brooklyn Traction	100	9	12
" " pref.	100	..	53
Buffalo St. Ry	100	72	..
Cleveland City Ry.	100	68	70
Cleveland Electric Ry.	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	48½	..
Consolidated Traction of N. J.	..	26	30
Electric Traction, Philadelphia	50	74	74¼
Long Island Traction	100	11	11½
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	88
Metropolitan Traction, Philadelphia	100	93¼	94⅛
New Orleans Traction	100	14½	16
" pref.	100	56	60
North Shore Traction	100	23	28
" " pref.	100	80	84
People's Traction $30 pd.	25	61⅞	62
‡Philadelphia Traction	50	83	83¼
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	68½	69
" " pref	100	..	92
Worcester Traction	100	13	16
" " pref	100	83	37
BONDS			
Buffalo St. Ry. 1st con. 5s	100	104	105
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	98	..
Rochester St. Ry. 1st. 5s	100	95	97
*Union Ry. 1st. mtge 6s	100	105	108
*Westchester Electric 1st. mtge. 5s	100	98	101

* With accrued interest.

† Ex-Div.

‡ Ex-rights

LONG ISLAND TRACTION.—The committee which has been engaged for several weeks in devising a plan of reorganization for the Long Island Traction Company has virtually concluded its task, and submitted a report to the directors. It is understood that an assessment of nearly $10 will have to be made on each share of the stock in order to enable the company to hold the lease of the big trolley system. Ex-Governor Flower, who recently became largely interested in the company, said that the road is in bad shape and that there is to be a radical change in the management.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, June 3, 1895.

COL. J. H. SHAY, of the Chas. Munson Belting Company, Chicago, was in the city last week.

TELEGRAPH COMPANY SOLD.—The Amagansett & Easthampton Telegraph & Telephone Company's line has been sold to Jonathan T. Gardiner, a wealthy resident of Easthampton, L. I.

MR. J. H. RHOTEHAMEL, president of the Columbia Incandescent Lamp Company, of St. Louis, was in New York last week and gave encouraging accounts of the improvement noted in the lamp trade.

UNDERGROUND WIRES.—An ordinance compelling telephone and telegraph companies to remove their poles from the streets of Jersey City and place their wires in conduits was passed by the Aldermen of Jersey City last week. The ordinance becomes operative in July.

FIRST STEINWAY CAR TO FLUSHING.—The first trolley car to Flushing on the Steinway Railway line left Long Island City at 10.30 o'clock a.m., June 1. The car was decorated with flags and bunting. It carried the officers of the railway and a crowd of passengers. Cars will be run regularly to Flushing hereafter.

TROLLEY CAR COLLISION.—Trolley car 2,012 of the Flushing Avenue line, Brooklyn, bound for Fulton Ferry, jumped a switch at the corner of Washington and Flushing Avenues on May 31 and struck car 2,001 of the same line, which was going in an opposite direction. Both cars were filled with passengers, but none was seriously hurt.

TROLLEY CONDUCTORS UNDER BONDS.—All the conductors on the Brooklyn Heights Railway have been required to furnish bonds in $150. A guarantee company becomes surety, charging the conductors $2 each. A black list of conductors discharged for dishonesty is also kept, the object being to prevent them from getting employment elsewhere.

TELEPHONE SUIT ABANDONED.—Herts Brothers, of Broadway, who, in connection with Lawyer Simon Stern, began suit against the Metropolitan Telephone Company some time ago to secure lower rates for their telephone service, have withdrawn their suit, paying all costs to date, and have signed contracts for telephone service at the regular rates established by the company.

ELECTRICAL EQUIPMENT FOR "L" TRAINS is being vigorously agitated, and rumors, purporting to be authentic, are current to the effect that the change from steam to electricity is being seriously considered by the officials of the Manhattan Company. It is thought by many that success in Chicago will mean the certain adoption of electric motors here. The public at large is heartily in favor of the change.

TROLLEY CARS FOR THE SOUTHERN BOULEVARD.—The Union Railway Company is preparing to extend its trolley lines through the Southern Boulevard from Lincoln Avenue to West Farms, but is delayed, it is said, by the Board of Electrical Control in the matter of obtaining permits. The company is doing the surface work, and says that the road will be in working order in a short time the permits can be obtained without delay.

THE FLYNN FRANCHISES.—The Kings County Grand Jury has been investigating for three weeks the action of the Brooklyn Board of Aldermen of 1893 in granting the franchises to the Flynn electric railway companies. The inquiry was started directly after the franchises had been declared void by Justice Smith of the Supreme Court. In his decision Justice Smith scored the 13 Aldermen who voted away the valuable grants without any regard to the interests of the city.

GENERAL ELECTRIC TO MOVE?—It is the general impression in Schenectady that the General Electric Company will consolidate all its works at some New Jersey town and give Schenectady the cold shoulder, but nothing reliable can be learned concerning this further than that an offer of some sort of bonus has been made the company by a New Jersey town. Director F. G. Hastings says he can see no reason why such a change should be made, as the expense involved in moving would probably offset any bonus and other advantages that might accrue.

A DECORATION DAY CASUALTY.—Trolley car No. 88, of the West End division of the Atlantic Avenue Railway, Brooklyn, drawing three open trailers, all crowded with passengers, halted on a Unionville switch at 8 o'clock p. m., Decoration Day, on a return trip from Coney Island. The rear trailer, without the knowledge of employees, rested on the main track. Trolley No. 371 of the same line, in charge of Motorman Robert Sterling, came unobserved upon the car, and a crash resulted, which overturned both cars and splintered the other

cars of the stationary trains. No one was killed, but Motorman Sterling was seriously crushed.

INCREASED WAGES.—All the employees of the Brooklyn Elevated Railway Company with the exception of the engineers are to receive an advance in wages on June 1. The pay was reduced 10 per cent. in October, 1893, because of the reduced receipts, and the advance will restore the old figures. In the notice announcing the increase in pay, the general manager states that there is no danger that the wages will again be reduced, because the earnings of the company as now assured will permit of fair wages so long as the streets of Brooklyn are not used for rapid transit purposes. The notice also states that the company is only enabled to increase the wages because high speed is no longer possible on the surface lines in consequence of the new city regulation.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
ROOM 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, June 1, 1895.

FREE TRANSFERS COMPULSORY.—The Massachusetts House has passed a bill requiring the West End Company to issue free transfers. The bill, however, after considerable and heated discussion in the Senate, was defeated in that body by a 30 to 6 vote.

EXTENSIONS IN THE WEST ROXBURY DISTRICT.—A movement is progressing successfully in this section to construct an electric railway, which will start near Keyes Street, Jamaica Plain, the terminus of the West End tracks, and follow such a route as may be selected, through Roslindale and the various villages of West Roxbury. The stock subscription paper is now making its rounds with the most auspicious augury for success.

INJUNCTION REFUSED.—Chancellor Rowell has refused the injunction petitioned for by the Estey Organ Company and ex Governor Levi K. Fuller et al, to restrain the Brattleboro Street Railway from using electricity as a motive power and from extending its line in the village of Brattleboro, Vt. Judge Rowell gave as his reasons for refusing the petition that the railway had a right to use electricity as a motive power; that the preliminary steps had been taken as required by the statutes, and that the building of the street railway, as proposed, constitutes no additional burden on the soil.

CANADIAN NOTES.

TORONTO, Can., June 1, 1895.

MONTREAL, CAN.—The Lachine Council has passed a motion permitting Mr. Bickerdike to build an electric railway on St. Joseph Street.

PORT HOPE, ONT.—P. R. Randall addressed the counsel of the Corporation of Hope, at a regular meeting held at Port Hope, respecting the advisability of submitting notice of motion of introduction of a by-law at next meeting, for the purpose of granting an electric company the right to build a trolley track on the portion of the Rice Lake Gravel Road, situated within the limits of the township of Hope.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, May 22, 1895.

THE ELECTRIC LIGHTING OF FACTORIES.—A "Factories and Workshops Bill" is now before the House of Commons, and an amendment was recently made in it which should give a considerable fillip to electric lighting in factories. The bill contains a clause empowering the Home Secretary to increase the minimum number of cubic feet of space allowed per employee in the case of work by artificial light. An amendment has, however, been introduced exempting shops, etc., lit by electricity from the operation of this clause. In places where space is an object, and where night work is the rule or very frequent, the advantage of adopting electric light will be considerably increased by the passing of this act.

MUNICIPAL PURCHASE OF ELECTRIC LIGHT UNDERTAKINGS.—The electric supply of the town of Newcastle is at present undertaken by two companies, which supply current to the public at about 4½d. per kilowatt-hour. The Town Council, owing to the comparative success of these concerns, recently began to cast longing eyes upon them, and consulted Prof. Kennedy as to the advisability of the concerns being immediately purchased by the Municipality, instead of waiting until the time for compulsory municipal purchase came about in the usual course. Prof. Kennedy in a lengthy report states that owing to the fact that these companies are supplying current at such a low rate, and owing to the extremely low cost of management, etc., it is difficult for him to point out where the municipality could effect a saving, and if any saving were to be effected, it would be necessary, if the municipality were to purchase the undertakings of these companies, upon the basis of the 5 per cent dividend they are now paying, to increase the price per unit from 4½d. to 6d., since otherwise the municipality would be unable to provide interest on capital, a sinking fund and a renewal fund; and even if the companies could be purchased for a price equivalent to the capital they have actually expended without any allowance for good will, such is the economy practised by them that the consumers of electricity would not gain pecuniarily by municipal purchase in this case.

INQUIRY INTO THE TELEPHONE SERVICE.—The Parliamentary inquiry into the telephone service of the United Kingdom still continues though the proceedings of Tuesday last were not of a particularly interesting or instructive description. On Tuesday, however, Mr. James Tatts Forbes, President of the National Telephone Company, made an extremely instructive and lucid statement. Among other things he brought out was that the charge in England for an exchange connection was £9 2s. 2d., which he showed was approximately 6d. per diem, and which he naturally pleaded cou'd not be considered an exorbitant tax. According to Mr. Forbes there are now over 73,000 subscribers in the United Kingdom, and 498 exchanges, a large number of which are on metallic circuits. With regard to the allegations of extravagant profits, Mr Forbes brought forward figures to show that the working of the National Company amounted to 62 per cent. of the revenue, and that the present charges made by the company might be considerably reduced were there no postoffice royalties, way-leave charges, and high wages. He further stated that at the beginning of the month his company circularized their 70,000 odd London subscribers with the result that they had received some 2,700 replies, over 2,500 expressing entire satisfaction with the company's metropolitan service. I may say that the London County Council almost simultaneously circularized the London subscribers of the National Telephone Company, receiving 2,500 replies, only 555 of which expressed satisfaction with the company's service. The evidence of Mr. Forbes was not concluded when the committee rose on Tuesday and it will be continued on Friday next.

LEGISLATION BY THE BOARD OF TRADE.—In the original electric lighting act of 1882, local authorities were given the option of purchasing electric lighting undertakings at the end of a period of 21 years, and it was this brief period, which, more than anything else, tended to retard the introduction of electric lighting into England. The Act of 1888 extended the period to 42 years, and made the terms of purchase somewhat more clear, though certainly not less onerous. It has been a general source of complaint among electrical men in this country that this extension of the period from 21 to 42 years, which was obtained after so much fighting, has been whittled away by electric light company promotors. The favor of the local authorities is a necessary antecedent to the granting of electric lighting branches, periods as short as 21 years having in some cases been stated by promoters, and now the Board of Trade has taken a step which it would seem is *ultra vires*. It has declined to grant orders for any part of the metropolitan area unless the power of purchase by the local authority is allowed to come into effect, not at the end of 42 years from the granting of the order, but at the end of 42 years from August, 1889, when the majority of the electric lighting provisional orders to the metropolis were granted. This, no doubt, is done for the purpose of ensuring that the orders of all the companies in business in the metropolis shall expire at the same date, and that the local authorities, if desirous of puchasing, shall not be obliged to take over these concerns piecemeal, as they are now being obliged to do in the case of the tramways of London. No doubt this result is one which is for the public good, but the means by which the Board of Trade is endeavoring to attain it seems decidedly outside of the law.

General News.

NEW INCORPORATIONS.

THE TEXAS ELECTRIC COMPANY, Austin, Tex., has been incorporated by C. . Hobson and others, with a capital stock of $5,000.

THE DUPLEX CAR COMPANY, Concord, N. H., has been organized by Ex-Gov. H. A. Tuttle, of Pittsfield; Hon. S. S. Jewett, Laconia, and others. Capital stock $1,000,000.

THE PLYMOUTH WATER, LIGHT & POWER COMPANY, Sheyboygan, Wis., has been incorporated with a capital stock of $50,000 by H. G. Malone, H. E. Dow and S. J. Foote.

THE WOOD COUNTY TELEPHONE COMPANY, Grand Rapids, Mich., has been incorporated by John A. Gaynor, H. H. Voss, and George L. Williams, with a capital stock of $5,000.

THE CANALES TROLLEY COMPANY, Springfield, Ill., has been incorporated by F. William Canales, Portland, Me.; A. M. Ross, L. Henry Pearse, Boston, Mass. Capital stock $100,000.

THE PHŒNIX CONSTRUCTION COMPANY, Indianapolis, Ind., has been incorporated by N. J. Clodfelter, Jacob Frankel, C. M. Waterbury, J. W. Paris, and C. A. Meeker. Capital stock $100,000.

THE MORAVIA ELECTRIC POWER COMPANY, Los Angeles, Cal., incorporated by U. N. Monroe, C. T. Dorland, J. H. Partle, Moravia; H. V. Carter, and J. F. Sartori, of Los Angeles. Capital stock $100,000.

THE NORTHERN ELECTRIC COMPANY, Norwalk, O., has been incorporated by Parks Foster, of Elyria; George P. Jones, of Findlay, and B. P. Foster, Mayme C. Foster and J. W. Foster, of Norwalk. Capital stock $25,000.

THE SPRINGER ELECTRIC COMPANY has been incorporated at McCordsville, Ind., with a capital stock of $10,000, to manufacture electrical appliances, construct telephones, etc. The promoters are T. L. Springer, A. C. Morrison and Seymour Morrison.

THE TICONDEROGA TELEPHONE COMPANY, Glens Falls, N. Y., has been incorporated to operate a line from Addison Junction to Rogers Rock Hotel, Fort Henry, Chilson, Schroon Lake, Whitehall, Hague, Bolton, Caldwell and Glens Falls. Capital stock $5,000.

TELEGRAPH AND TELEPHONE.

AMHERST, N. S.—The Nova Scotia Telephone Company contemplates running a line from Amherst to Oxford.

ALBION, N. Y.—The Norton-Troutburg Telephone Company is making arrangements to extend its telephone line to Holley.

MIDDLETOWN, N. Y.—City Attorney J. L. Wiggins has received from the Secretary of State's office, at Albany, the certificate of the Orange County Telephone Company.

NEW OXFORD, PA.—The Town Council has passed an ordinance granting right of way over the streets and alleys of the borough to the Hanover Telephone Company.

OCONTO, WIS.—The Oconto Electric Light & Fuel Company will enlarge its business. It intends to transform the lower story of its glass factory into a manufactory of telephone instruments.

CLARKSVILLE, N. Y.—A corporation for the purpose of building a telephone

line between Clarksville and Jerusalem was organized at Houck's Hall recently. Cornelius Slingerland is president; R. C. Bagley vice-president, and Charles Hummer, secretary.

Electric Light and Power.

ARMOUR, IA.—A franchise has been granted to F. D. Day to put in an electric light plant.

WESTPORT, MO.—The City Council has passed a resolution authorizing a city gas or electric light plant.

PENSACOLA, FLA.—The Citizens' Electric Light & Power Company will largely increase the capacity of its plant.

BELLEFONTAINE, O.—The City Council has ordered that the clerk advertise for contracts to build an electric light plant.

CAMDEN, ARK.—The dynamos for the electric light company were almost totally destroyed by a runaway engine. Loss, $1,000.

SOMERSET, PA.—The Somerset Electric Light Company has decided that increase of its plant and improvements will be made at an early day.

SANDERSVILLE GA.—The City Council has ordered an election to be held July 15, to vote upon issuing $15,000 of bonds for water works and electric light plant.

CROCKETT, TEX.—The City Council has granted to F. Lockfield, of Waco, Tex., a franchise to put in an electric lighting plant, to be in operation Oct. 1.

ALEXIS, ILL.—H. S. Lafferty has been granted a franchise to establish an electric light plant at Alexis. For information address H. S. Lafferty or Ben. Strong.

FLAGSTAFF, ARI.—The proposition of J. D. Moore of Prescott, for an exclusive electric lighting franchise has been refused by the city. The city will secure estimates on the cost of a plant.

WORCESTER, MASS.—At a meeting of the Board of Aldermen recently a petition was read from the Worcester Electric Light Company asking to lay underground conduits for the accommodation of its wires.

EAST LIVERPOOL, O.—E. H. Wells & Co., of Wellsville, will put in an electric light plant in the basement of their big building. The electric plant will also be used to run electric fans in all the stores which it supplies.

OMAHA, NEB.—The South Omaha Water Works Company has been formed for the purpose of erecting and maintaining water works and electric light plant. Wm. Paxton, John A. Creighton and Louis Schroder are interested.

BATON ROUGE, LA.—The Home Electric Company has been organized by Samuel G. Laycock, as president, and C. J. Barrow, vice-president, with a capital stock of $100,000, to succeed the Baton Rouge Electric Light & Power Company.

NATIONAL HOME, CAL.—At the Pacific Branch, National Home for Disabled Veteran Soldiers, bids will be received until 2 p.m., June 20, at the office of the governor of the home, for furnishing all materials and labor and completing an electric plant to cost less than $10,000.

MECHANICSBURG, PA.—A town meeting was held May 25 to consider the electric light question. A resolution instructing the Town Council to refuse to consider any proposals that would not locate the plant within the borough limits was adopted. Col. R. H. Thomas presided at the meeting.

SPRINGFIELD, MASS.—The committee to whom was referred the petition of the telephone company for leave to erect and string poles on Main Street from State Street to Mill River, presented a report granting the locations. Mayor Long asks that action be deferred on the report, after he had explained the prospects of inducing the company to place its wires in conduit. The committee prepared a new report giving the company leave to withdraw.

The Electric Railway.

DEFIANCE, O.—A power house of the Defiance Lake Railway Company was partially burned recently; loss $7,000; fully insured.

PLATTSBURGH, N. Y.—A proposition has been made to the people to build and equip a trolley road from Kanona to Plattsburgh.

MERIDIAN, MISS.—S. H. Gehlman and L. B. Bradley are interested in a project to build an electric street railway five miles long.

NEW BRITAIN, CONN.—The Central Railway & Electric Company has petitioned for permission to extend their line to Hartford.

HARTFORD, CONN.—It was voted at a recent meeting of the Board of Alderman to double-track the line of the Hartford Street Railway Company.

PENN'S GROVE, N. J.—It is reported that work will soon be commenced on a trolley line from Penn's Grove to Salem. A charter has been secured.

SKOWHEGAN, ME.—It is reported that the managers of the Skowhegan & Norridgwock Electric Railway have voted to expend $5,000 in improvements on their road.

NEWARK, N. J.—The Passaic & Newark Electric Railway Company has broken ground and work will shortly commence on the construction of its road at Franklin.

CLARKSVILLE, TENN.—The Clarksville Street Railway Company is prepared to receive proposals for machinery, cars, etc., for an electric railway. Wm. N. Daniel is president.

WATERLOO, N. Y.—The Village Board of Trustees has granted the right of way to Main Street, connecting the Geneva & Waterloo Railway, with the road running to Seneca Falls.

SOUTH AMBOY, N. J.—Representatives of the proposed electric railway will appeal to the Mayor and Council of South Amboy for a franchise to run the road through certain streets of the borough.

PORT HURON, MICH.—Mayor Boynton and other Port Huron capitalists propose to build an electric railway from Port Huron to Algonac along the river, thence to Chesterfield, so as to connect with the Grand Trunk road.

WRENTHAM, MASS.—The Board of Selectmen has refused to give to the Interstate Consolidated Railway Company a franchise to run electric cars in this town, until the company grants certain concessions, which it is not inclined to do.

WYOMING, PA.—The project to build an electric branch at Mt. Lookout, back of Wyoming, is again being revived. John Graham, of the Traction Company, Builder Phil. Rafe Chris Stemeyer, and John A. Hutchins, Wilkesbarre, are interested.

CHARLESTON, S. C.—John R. Hoefgen and Edgar Moxham, of Brooklyn, N. Y., represent the syndicate which is said to have purchased a controlling interest in the Enterprise & City Street Railways, and which will convert them into a trolley system.

BRAINTREE, MASS.—The Braintree, Randolph & Holbrook Street Railway Company has reorganized its directory. J. F. Sheppard, W. O. Chapman and Charles H. French have been elected. It is said that the connection with Quincy will be built soon.

STONEHAM, MASS.—The plan for an electric street railway between Stoneham, Winchester and Arlington, which was agitated about a year ago, is being revived. Onslo Gilmor, of Stoneham, and A. D. Cochran, of Winchester, will be on the board of directors.

TOLEDO, O. The Council committee on Railways and Telegraphs met and approved an ordinance to grant the Toledo Consolidated Street Railway, or Toledo Traction Company, right to operate an underground system of conduits for the transmission of electricity for light and power purposes.

TROY, N. Y.—A meeting was recently held in Troy which assures at least an electric road from Albia to Averill Park, and is said to be the beginning of the Troy & New England railway line, as it is upon the charter of that company that the road begins. President, George T. Lane; vice-president, Wm. A. Thompson.

BROCKTON, MASS.—Another electric railway in all probabilities will soon be built. The name of the corporation will be the Brockton & Northeastern Street Railway Company, and the line will be practically an extension of the present one. John P. Morse, Judge B. Reed and Horace B. Rogers, of Brockton, are interested.

Personal Note.

MR. STEPHEN LEIDY COLES, of the *Electrical Review*, was married to Miss Sallie E. Field, at New York, on Saturday, June 1. While the bachelor portion of the electrical fraternity is thus deprived of one of its most jovial and sympathetic members, now that the deed is beyond recall they will all join with the benedicts in wishing the happy couple all the bliss that matrimony holds in store for the most fortunate of its devotees.

Miscellaneous Notes.

MR. PHILANDER BETTS, of Hackensack, N. J., who for a number of years has been prominently engaged in electrical construction work, has been appointed electrician at the Washington Navy Yard. Mr. Betts secured the appointment in competition with 27 other applicants.

THE HENRY ELECTRICAL CLUB.—At a regular meeting of the Henry Electrical Club held at the rooms of the American Institute, New York, on May 28, the following officers were elected for the ensuing year: W. H. Freedman, president; L. H. Landy, first vice-president; Max Osterberg, second vice-president, and Geo. Whitefield, secretary. A resolution was adopted expressing the regret of the members of the club at the untimely death of Mr. George M. Phelps, and referring in high terms to his services in the interests of the electrical profession in this country.

Trade and Industrial Notes.

THE ERIE CITY IRON WORKS has removed its Chicago office from 1510 Old Colony Building to 34-38 West Monroe Street.

W. H. MACKAY has been appointed New York agent for the Columbia Incandescent Lamp Company, of St. Louis Mo., with offices at 1103 Havemeyer Building.

AN EXTENSIVE LIST OF ENGINE USERS is incorporated in a little pamphlet which the Ball Engine Company, of Erie, Pa., is distributing, which includes electric light and power companies in every State from California to Maine and between Lake Superior and the Gulf of Mexico.

AN ARTISTIC CATALOGUE.—Good taste and sound argument are embodied in the Robb Engineering Company's new engine catalogue. From the fine embossed front cover through the detailed description of the Robb-Armstrong engines to the last blank fly leaf, these two features are conspicuous.

A MOST GRATIFYING LETTER has been received by the General Electric Company from a western central station testifying to the satisfaction experienced in the operation there of a monocyclic plant. The writer states that the system has been in constant operation for two months without a single hitch, and that the dynamos and motors run cool and practically without attention.

W. C. KIDD, 239 Broadway, New York, general sales agent for Coe's grate bars, reports that wherever these bars have been used they have given entire satisfaction. As an evidence of this assertion he has a large number of complimentary letters from purchasers which can be seen at his office, and which speak in high terms of the efficiency, economy and convenience of these grate bars.

LARGELY INCREASED FACILITIES have been found necessary by the Philadelphia Electrical & Manufacturing Company, 20th and Jones Streets,

Philadelphia, owing to the constantly increasing demand for its improved cut-outs and spark arresters. Additional machinery has, therefore, been put in the factory and several extra men added to the force, so that the company will now be able to fill orders more promptly.

TASTEFUL DESIGN characterizes the new catalogue of H. E. Collins & Co., Pittsburgh, Pa., in which detailed information is presented concerning the "Cahall" vertical water-tube boiler. The book is handsomely illustrated and is replete with data obtained from exhaustive tests of Cahall boilers and thorough analyses of the coal used during the tests. Ten features of advantage are pointed out as being embodied in these boilers. The catalogue, however, makes interesting reading aside from trade considerations.

"INTERESTING FACTS" is the title of a well-prepared pamphlet which the Packard Electric Company, Warren, O., is distributing. The title is by no means a misnomer; the pamphlet contains curves showing the maintenance of candle-power and increase in efficiency with use, which are peculiar to Packard lamps, and also calls attention to the relative values of high-grade and cheap lamps which is of vital interest to users of incandescent lamps. Packard transformers are not neglected in the pages of this unique little circular.

THE ADVENT OF SUMMER has given an impetus to the fan business generally and particularly to that of the Metropolitan Electric Company, Chicago. Dayton ceiling fans, Victor direct-current desk fans and Ries-Scott alternating desk fans are tumbling over each other in the rush to fill orders. Comfortable orders are being received, too, for Keystone ammeters and voltmeters and Ayer arc-lamp windlasses, for which the Metropolitan Company is western agent. Metropolitan arc lamps for incandescent circuits are likewise in demand. The company will soon issue a comprehensive and handsomely prepared catalogue.

THE HESSIAN FLIES, which have caused so much damage to wheat, says the Central Electric Company, of Chicago, stand in awe of Lundell fan motors and maintain a most respectful distance from them. The sudden advent of summer temperature has caused vigorous inroads to be made upon the company's stock of fans, but the vacancies are filled about as soon as they are made. The prospects for the fan trade this season are reported as exceedingly promising. A steady demand is also reported for "Interior" conduit and kindred supplies; a recent order for an Illinois postoffice building covered several thousand feet of conduit.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, in its new catalogue B presents such full instructions for the installation and care of accumulators as to make the book almost a technical treatise. Exhaustive descriptions are given of the "Chloride" batteries made by this company, following which there are curves showing the variation in E. M. F. during charge and discharge and capacity at different discharge rates. Then there are eight different diagrams of connection and other data too numerous to mention. The book is executed elegantly and substantially. Owing to the great expense of production a charge of $1 is made for the catalogue.

THE BURNLEY CARTRIDGE BATTERY, manufactured by the Miamisburg (Ohio) Electric Company, has been adopted exclusively by some of the largest telephone companies in the country, the makers say, after a competitive test with other batteries on the market. The company offers these batteries on their merits and invites those interested to test them. The Imperial dry battery still maintains its high reputation and is rapidly overcoming the prejudices against dry batteries caused by experimental and defective goods put on the market from time to time. The Miamisburg Electric Company is the only manufacturer of Burnley's improved dry battery, which is put on the market under the name "Imperial."

AN ATTRACTIVE CATALOGUE has been issued by the Columbia Incandescent Lamp Company, of St. Louis, in which are described all styles, sizes and shapes of lamps. The Columbia company calls attention to the fact that notwithstanding the reduction in prices during the past year, nothing has been omitted in the construction of Columbia lamps which was at all essential to the maintenance of the high standard by the company at the outset some six years ago. A point is also made of the fact, too often ignored by purchasers, that low first cost is by no means a criterion of merit. The Columbia company claims to have effectually overcome the difficulty at first experienced with high voltage lamps, and that a most gratifying demand is being made for the 220-volt lamps.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MAY 28, 1895.

{In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

589,786. CONDUIT ELECTRIC RAILWAY SYSTEM; F. Barrell, New York, N. Y. App. filed July 19, 1894. The combination of a lateral wire conductor formed in sections within a conduit, with cushioning devices interposed between adjacent sections, preventing jarring or any vibration of the parts.

589,796. COUPLING; T. J. Close, Philadelphia, Pa. App. filed July 10, 1894. The combination of two or more sections of a rod or tube, one part having a recess, side bars and cross bars, and the other provided with tongues and recesses, the said parts being adapted to interlock with each other. (See Illustration.)

539,798. COMBINED TROLLEY HEAD AND WHEEL; Wm. H. Dalbey, Indianapolis, Ind. App. filed Oct. 11, 1894. A self-lubricating trolley wheel containing an interior reservoir for graphite and provided with a bushing having holes therein for the admission of lubricant.

589,799. LANTERN FOR BICYCLE RIDERS; W. K. L. Dickson, Orange, N. J. App. filed Aug. 4, 1894. The combination of a lantern having a reflector secured to support an incandescent lamp mounted on a base of insulating material, having a switch, binding posts, circuit wires and a resistance.

589,804. ELECTROMAGNETIC GOLD SEPARATOR; J. D. Gibbens and W. B. Murray, Portland, Ore. App. filed Oct. 20, 1894. The combination of a stepped extension, a sluice-box having grooved copper plates adapted to be filled with mercury for amalgamating purposes, electromagnets arranged in gangs having a common armature, set screws projecting through the armature to the under side, upon which magnets are adapted to rest, so that the same may be adjusted.

589,825. ELECTRICAL CONNECTION; P. Rieth, Chicago, Ill. App. filed Feb. 28, 1895. An electrical connector having tubular tapered cones adapted to engage with cylindrical terminals open at both ends; the said ends being capable of being swaged so as to rest against the rail.

589,832. CEILING BOARD; H. O. Stillwell and J. D. Broman, Chicago, Ill., App. filed July 10, 1894. The combination of a binding post connected with one side of the mains and provided with two contact terminals, a second post connected with the opposite side of the mains and also provided with two contact terminals arranged opposite the contact terminals of the first binding post; a switch lever adapted in one position to close together the opposed terminals to afford two paths for the current from one binding post to the other, the second position of the switch being adapted to connect the lamp terminals one with each of the posts, the switch lever closing the opposed terminals of the posts before opening the circuit through the said lamp.

589,838. PROCESS OF PRODUCING INCANDESCING BODIES FOR ELECTRIC LAMPS. K. O. E. Troback, Pankow, Germany. App. filed April 18, 1894. The process of producing carbon bodies for electric lamps, consisting in subjecting the substance to a preliminary purifying treatment, then immersing the same in an acid, and subsequently carbonizing the said substance.

589,840. SAFETY SYSTEM FOR RAILWAYS; A. L. Ware, Cambridge, Mass. App. filed Oct. 15, 1894. The combination of two parallel main conductors, one of which is of high resistance, a plurality of cross-connections, each carried by a car, and two of them requisite to complete a circuit of which the main conductors form a part; an alternating dynamo as a current generator in each cross-connection and a translating device, all constructed and arranged to form circuits the resistance in which varies with the distance apart of the trains.

589,849. ELECTRIC MOTOR; J. B. Atwater, Chicago, Ill. App. filed Sept. 24, 1894. The combination of cam rings, formed with acute and obtuse inclined surfaces, connected to power-transmitting means, a plurality of electrically operated traction levers provided with a friction wheel and adapted to engage with the cam rings, a switch and means for operating the same, and a fly-wheel.

589,854. TROLLEY BREAKER; W. G. Carey and A. A. Ball, Jr., Schenectady, N. Y. App. filed Nov. 15, 1894. A body having a rectangular section for trolley-breaking, composed of insulating material having its ends sloped off, and a slot in each end for securing the metallic end-pieces in position.

539,868. CONTROLLER FOR ELECTRIC SEARCH LIGHTS. E. P. G. H. Faure, J. MacHaffie and S. H. Libbey, Schenectady, N. Y. App. filed Jan. 29, 1895. The combination of a controller having a switch handle adapted to move simultaneously in a horizontal plane and vertical plane imparting a diagonal motion to the handle and springs to bring the handle back to its normal position. (See Illustration).

589,870. ANNUNCIATOR; F. A. Jennings, Ithaca, N. Y. App. filed Mar. 23, 1893. An annunciator comprising a case, a rotatable cylinder, a ratchet and pawl for rotating it, and a cam actuating the mechanism; a dial provided with a series of notices, a pointer mounted upon a rotating shaft, with a motor rotating the said shaft, and adapted to shift the said pointer from one notice to another, by the making and breaking of the circuit, and an aperture in the dial exposing a title on the said cylinder.

539,871. GALVANIC BATTERY; H. T. Johnston, New York, N. Y. App. filed Nov. 10, 1893. The combination of a metal vessel forming the positive electrode, a negative electrode therein, a semi-solid filling between the electrodes, a seal closing the top of the positive electrode and a projection engaging with the seal.

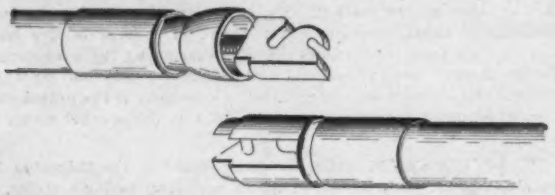
539,876. STATIONARY TRANSFORMER; W. S. Moody, Lynn, Mass. App. filed May 15, 1894. A transformer having a core composed of laminæ having registering notches upon their inner edges, forming oil channels in combination with primary and secondary windings arranged within the core.

539,877. ELECTRIC ARC LAMP; J. A. Mosher, Chicago, Ill. App. filed May 1, 1893. The combination of an upper carbon rod, pivoted frame carrying a feeding train, a shunt solenoid having a core, connected to the frame, a rocking plate with notches at its upper end, a dog adapted to enter said notches, pellets carried by the said rocking plate and means for raising the core.

589,881. ARMATURE COIL AND METHOD OF MAKING SAME; O. F. Persson and D. P. Thomson, Schenectady, N. Y. App. filed Oct. 6, 1894. An armature coil having an hexagonal figure, four of the sides of which are curved to conform to the shape of the armature core, the other two parts lying in different planes and joined by a part radial to the curved sides.

539,886. ELECTRIC METER; E. Thomson, Swampscott, Mass. App. filed Feb. 18, 1895. A meter having stationary and shunt coils, an oscillating coil or armature arranged transversely to the stationary coils and acted upon differentially by the latter, and a circuit breaker in the shunt circuit controlled by the movement of the oscillating coil.

539,931. RAIL BOND; F. E. Buxton, Worcester, Mass. App filed April 15, 1895. An electric rail bond comprising a wire having cone-shaped heads upset at either end and two loose collars having conical bores of slightly smaller diameter than the said heads.



No. 539,796.—Coupling for Electric Conductors.

539,939. ELECTRIC CABLE; W. D. Gharky, Philadelphia, Pa. App. filed Oct 18, 1894. A cable consisting of a conductor forming a core and an insulating wrapper surrounding the core, a testing wire extending along the cable outside of the insulating wrapper.

539,943. ARMATURE WINDING AND METHOD OF MAKING SAME; W. Hochhausen, Brooklyn, N. Y. App. filed Feb. 10, 1888. The combination of a cylindrical or drum armature, a multiple conductor having its strands assembled into a cable on the said armature periphery and flattened, upon the armature head so as to cover a less superficial area on the head than upon the periphery.

539,966. ELECTRIC BELL; C B. Sterling, New York, N.Y. App. filed March 14, 1895. The combination of a bell, hammer, and a solenoid having a core, a circuit maker and breaker loosely connected to the said core and movable vertically, stationary contacts insulated from each other to engage the circuit maker, guides and springs for the same, to keep it in its raised position.

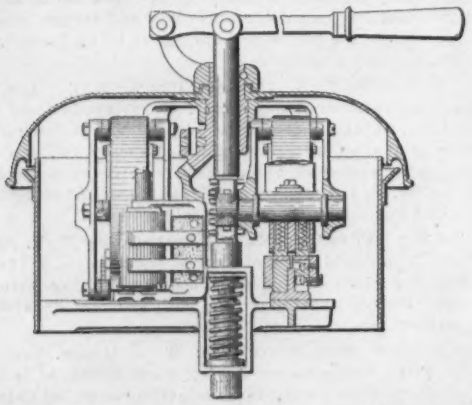
540,010. CONDUIT ELECTRIC RAILWAY; F. B. Widmayer, New York, N. Y. App. filed Aug. 3, 1894. The combination of a conductor encased in a suitable covering, a series of circuit-completers normally open and arranged at intervals along the road, an electrically-propelled car provided with means for successively throwing into operation said circuit completers.

540,012. TELEPHONE CENTRAL SYSTEM; G. D'Adhemar, Paris, France. App. filed June 20, 1894. The combination of a calling annunciator of an electromagnet, a local circuit, and means for automatically breaking the circuit of the electromagnet of the annunciator and at the same time returning the drop of the said annunciator.

540,025. CONTROLLING MECHANISM FOR LOCKS; R. A. Palmer, Boston, Mass. App. filed Feb. 4, 1895. A lock mechanism consisting of a two-part spindle adapted to be extended through the lock, one member of which is adapted to be operatively connected with a latch-bolt; a spindle coupling, an actuator for the same, and an electromagnet to positively move the actuator into operative position to couple the two members of the spindle.

540,029. MEANS FOR CONNECTING MOTORS TO CAR AXLES; S. H. Short, Cleveland, O. App. filed Oct. 19, 1893. The combination of an axle and truck frame, a swinging frame, slotted bearings at the free ends of the arms of said swinging frame, and a motor having trunnions adapted to enter said bearings and move therein.

520,035. BRUSH HOLDER FOR DYNAMO-ELECTRIC MACHINES; E Thomson, Swampscott, Mass. App. filed Feb. 20, 1893. The combination of a brush clamp and a support for the same, one swinging upon the other and means for maintaining the clamp always parallel to a given plane.



No. 539,863.—Controller for Electric Search Lights.

540,054. LOCATING FAULTS IN ELECTRIC RAILWAYS; J. C. Henry, Westfield, N. J. App. filed Jan. 24, 1894. In combination a supplemental return conductor for an electric railway connected at intervals to the track or ground return and divided into sections normally connected together, and means adapted to measure the current flow between the sections.

540,060. CONDUIT ELECTRIC RAILWAY; W. E. M. Jackson, San Francisco, Cal. App. filed Oct. 25, 1893. The combination of a conductor and an insulating support comprising an open spiral, or other form in which a piece of small cross-section is bent upon itself, with a long continuous free surface formed of insulating material.

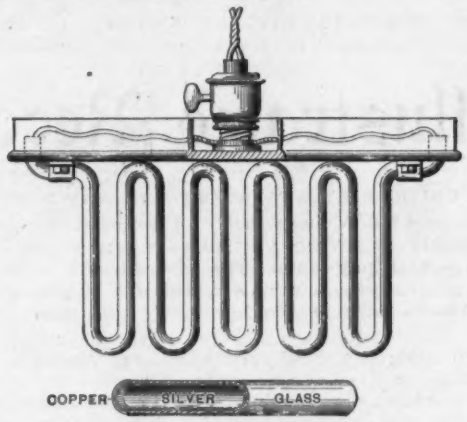
540,073. ELECTRIC HEATER; C. J. Reed, Philadelphia, Pa. App filed June 5, 1894. A heater consisting of a non-conducting tube having a thin film or coating of silver attached to its inner surface, the said film being connected at its opposite ends to conductors leading to a source of current supply. (See Illustration.)

540,076. SECONDARY BATTERY; W. L. Silvey, Dayton, Ohio. App. filed Jan. 21, 1895. The combination of a screw-threaded battery connector or post, battery plates and battery collars, the battery post passing through the plates and collars, porous plates surrounding the collars, porous sheets between the battery plates, the collars, plates and post connected together by a yielding strip.

540,090. ELECTRIC PASSENGER REGISTER AND RECORDER; Jos. W. Ellis, Albany, N. Y. App. filed Jan. 12, 1895. An electric registering and recording system, comprising a series of vertically movable step-plates, circuit closers controlled by these step-plates, two registers having electromagnetic actuators in circuit with the respective circuit-closers and provided with record cards, markers and magnetic maker-actuators, a clock provided with circuit-closing devices including a series of electric contacts, and an electric circuit connecting all these contacts with the electromagnets last named of both registers.

540,094. WATER WHEEL GOVERNOR; A. Giesler, Dayton, Ohio. App. filed Aug. 13, 1894. The combination of a shaft adapted to operate the gates of a water wheel, a centrifugal governor and train, and an electric governor and train, each geared to turn the gate shaft, and adapted to work independently or in unison to control the gate.

540,117. CONDUCTOR DISTRIBUTING FRAME; T. Spencer, Cambridge, Mass. App. filed Jan. 24, 1895. The combination of a series of fixed contacts arranged in groups along, and each projecting at its ends from, an insulating fixed support, each contact representing and forming the terminal of a loop or branch of the respective lines extending to the switchboard appliances, portable insulating strips; metallic contacts arranged in groups along said strips, and means for removably securing the portable strips in proximity to the fixed support bringing the other or free ends of their respective contacts into electrical connection.



No. 540,073.—Electric Heater.

540,153. PHASE INDICATOR FOR ALTERNATING CURRENTS; Michael von Dolivo-Dobrowolski, Berlin, Germany; assignor to the Allgemeine Elektricitäts-Gesellschaft, of the same place. App. filed Oct 27, 1893. In an apparatus for indicating and measuring differences between the phases of two electric alternating currents of like number of alternations, the combination, with a coil or set of coils for each current, the two coils or sets of coils being set at an angle to each other, and a metallic body rotatably arranged in the magnetic fields of said coils, of a device for opposing a counterforce to the rotation of said metallic body, and means for indicating the amplitude of the latter.

540,168. ELECTRICAL EXCHANGE; A. E. Keith, F. A. Lundquist and J. Erickson, Chicago, Ill. App. filed Nov. 7, 1894. The combination of a switchboard having a series of rows of contact points, a series of connectors arranged to co-operate therewith, each connector being normally connected with but one of the rows of contact points, and means for making and breaking the normal connection as soon as the connector is operated for making connection with any of the rows, whereby communication between any two of the subscribers is entirely secret from the others.

540,185. SECONDARY BATTERY; C. Payen, Philadelphia, Pa. App. filed Aug. 17, 1893. The combination of a central vertically ribbed conducting plate, with independent plates of crystallized active material on opposite sides of the conducting plate and in contact with its ribs.

540,187. CLOSED CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; H. A F. Peterson, Milwaukee, Wis. App. filed Mar. 26, 1894. The combination of a conduit having conductors arranged to extend through it, a section at one side of the said conduit, supported upon pivotal connections and carrying short sections of the conductors and adapted to be swung back into a position to simultaneously open the conduit for the removal of the contact devices and move said short sections of the conductors out of line of movement of the contact devices.

540,216. SYSTEM OF ELECTRICAL DISTRIBUTION; E. G. P. Oelschlaeger, Charlottenburg, Germany. App. filed April 6 1895. The combination of a source of alternating currents, two or more transformers having their primary coils connected in series and forming a part of the feeder circuit, through which a current of constant mean amperage is transmitted, and two translating devices or groups of translating devices adapted to operate at different potential, connected in parallel across the secondary circuits of the respective transformers.